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MEMOIRS
OF THE
GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

TERTIARY AND UPPER CRETACEOUS FAUNA OF WESTERN INDIA.
Ser. XIV.

Vol. I. 1. SIND FOSSIL CORALS AND ALCYONARIA,
by P. MARTIN DUNCAN, M.B. (Lond.), F.R.S., V.P.G.S., &c.

WITH 28 PLATES.

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A MONOGRAPH
OF THE
FOSSIL CORALS AND ALCYONARIA
OF
SIND.

I. *Introductory Remarks on previous Works relating to the Fossil Corals of Sind.*

In 1853 MM. d'Archiac and Jules Haime published their great work entitled 'Description des Animaux Fossiles du groupe Nummulitique de l'Inde.' It contained, amongst other subjects, a very elaborate description of many species of fossil Corals which were derived from unknown localities in Sind. These descriptions were contributed by the late Jules Haime, a zoophytologist of great power and a most conscientious observer. He noticed seventeen species of Corals, most of which were well-known forms in the Nummulite-bearing rocks of Europe; some, however, were new to science. But the situation of their original localities was masked by the statement that these fossils had been found in the Hala mountains—that is to say, in a geographical position which never had any existence. The exquisite delineations of the species given by MM. d'Archiac and Haime are of course of great value, but their monograph is of slight geological importance; they ignored all other Tertiary formations in Sind except the Nummulitic.

Although the exact localities whence the fossil corals submitted to MM. d'Archiac and Jules Haime came are unknown, it may be taken for granted that the majority came from Sind and one from Cutch.

The fossils had been collected by Captain Vicary and Mr. Blagrove and others, some years previously.

In 1863 the author of this Monograph examined the collections in the museum of the Geological Society which had been submitted to the two French palæontologists and was surprised to find that several species had not been described; moreover, the study of these forms left the impression on his mind that other Tertiary deposits besides the Nummulitic exist in Sind. The results of this re-examination were published in the 'Quarterly Journal of the Geological Society,' 1864, vol. xx., and the new species were described and delineated in the 'Annals and Magazine of Natural History,' April 1864. The list of species was then increased to forty-two in number, and some were stated to be of Miocene age, and others were considered possibly to be Pliocene in date. The communication to the Geological Society was made at the instance of Mr. H. M. Jenkins, F.G.S., and it appeared in confirmation of his belief that the Tertiaries of a vast area in the East, including those of Java, were Eocene and Miocene in age.

But the greatest interest excited by the labours of MM. d'Archiac and Jules Haime was in relation to the increased importance of the Nummulitic coral-fauna. Slight as was their addition to it, they helped to remove the impression that the early Tertiary ages were uncoralliferous. Since the publication of their great work, the magnificent coral-fauna of the Eocene of Western Europe has been shown to form but a part of a great development of coral-life, which left its evidences especially in those Alpine regions whose fossils have been so ably described by the late A. E. Reuss and by Catullo and D'Achiardi. The Eocene coral-fauna of the West-Indian islands, described by the author of this Monograph, added interesting forms to the fauna.

Now that the Tertiary strata of Sind have been examined by the Geological Survey of India, and the corals have been carefully collected from localities whose stratigraphical position has been ascertained, the older Tertiary coral-fauna is very considerably increased. In fact, the Nummulitic strata, divided or not into Eocene and Oligocene, contain a coral-fauna as important as that of the Miocene age.

Not only has the examination of the fossil corals lately obtained by the Geological Survey of India from Sind added to the numbers of the Eocene species, but it also indicates that there is an upper series of coralliferous strata which merits the title of Oligocene. Again, other species clearly prove, what was formerly suggested was probably the case, that an important Miocene coral-fauna lived on the same area as that which had been previously occupied by the earlier Tertiary forms.

Amongst the collection of corals from Sind, the result of the careful labour of the Geological Survey under Medlicott and W. T. Blanford and Fedden, is a small series which was found on a lower geological horizon than the Nummulitic rocks. They required careful study, for the Cretaceous formation seems to merge into that of Lower Tertiary age in Sind.

II. *The Origin of the Collection about to be described.*

A very large number of specimens of the fossil Corals which had been collected in Sind were sent to the author of this Monograph by the kind direction of the Superintendent and Deputy-Superintendent of the Geological Survey of India. He has made the Corals and Alcyonaria his careful study, and their description forms his contribution to the Palæontology of India.

III. *The Stratigraphical Relations of the Coralliferous Series in Sind.*

The Survey of the Province of Sind by Messrs. W. T. Blanford, F.R.S., and Mr. Fedden enabled the first-mentioned of these geologists to describe the general geology of the area as follows*:—

"The greater portion of Sind, including all the richer and more populous parts of the province, consists of the alluvial flat of the Indus, and is a portion of the great Indo-Gangetic plain of Northern India. But to the west of the river, at a variable distance, barren rocky hills arise, in Upper Sind consisting chiefly of a great north and south range, known as the Khirthar, which separates Sind from the Kelat territory (or Balúchistán), and in Lower Sind, south of Sehwán, of several minor ranges, having a general north and south direction. All these ranges, if of any height, consist chiefly of Nummulitic limestone; and the ridges in Lower Sind are for the most part anticlinal rolls, higher beds occupying the intervening valleys. The Geology of the province is singularly simple, faults being rare, whilst the disturbance of the rocks is just sufficient to afford good sections, without rendering the relations of the beds so complicated as to be difficult to trace.

"Until recently the Geology was chiefly known from the researches of Captain Vicary, published no less than thirty years ago†; and these researches were limited to a very small province. The fossils collected by Captain Vicary and others were described and elaborately figured by MM. d'Archiac and Haime‡ in 1853, the whole of the marine fauna being supposed to be Eocene. It was, however, subsequently shown by Professor Martin Duncan§ and by Mr. Jenkins‖ that there was a mixture of later Tertiary forms amongst the supposed Eocene fossils, and it was noticed by Captain Vicary that above the marine beds were conglomerates and sandstones containing fossil bones.

"Such was, in brief, the information available when the Survey was commenced; and the result of a more thorough investigation has naturally added much, without depriving the earlier information of its value. Indeed the beautiful figures of d'Archiac and Haime's work have been of the greatest service in the field, by enabling us at once to identify many of the fossils found. The results of the first year's work have been briefly described in the Records of the Geological Survey¶; but much additional information has since been added, the most important being the recognition of Cretaceous beds at the base of the Tertiaries, and the confirmation of the view before announced, that a thin flow of basalt, representing the Deccan traps, underlies the Tertiary rocks. The beds of Sind are now classified thus in descending order:—

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* Proceedings of the Asiatic Society of Bengal, January 1878.

† Quart. Journ. Geol. Soc. vol. iii. p. 334.

‡ Description des Animaux Fossiles du groupe Nummulitique de l'Inde.

§ Ann. & Mag. Nat. Hist. ser. 3, vol. xiii. p. 295.

‖ Quart. Journ. Geol. Soc. vol. xx. p. 45.

¶ Vol. ix. p. 8.

Name.	Subdivisions.	Approximate thickness.	Supposed Geological age.	Remarks.
1. Alluvial, &c.	......	Unknown.	Recent and post-Tertiary.	
2. Manchhar.	Upper.	5000.	Pliocene.	Unfossiliferous; apparently representative of the Sevalik group.
	Lower.	3000 to 5000.	Lower Pliocene or Upper Miocene.	Fossiliferous, with Vertebrata.
3. Gáj.	......	1000 to 1500.	Miocene.	Highly fossiliferous; no Nummulites.
4. Nari.	Upper.	4000 to 6000.	Lower Miocene ?	Unfossiliferous.
	Lower.	100 to 1500.	Upper Eocene or Oligocene.	
5. Khirthar.	Upper.	500 to 3000.	Eocene.	Nummulitic limestone.
	Lower.	6000 ?	do.	Unfossiliferous.
6. Ranikot.	......	2000.	Lower Eocene.	Fossiliferous; nummulitic.
7. Traps.	......	40 to 90.	Upper Cretaceous.	Representative of Deccan and Malwa trap.
8. Cretaceous	*Cardita Beaumonti* beds.	350 to 450	Cretaceous.	
	Sandstones.	700		
	Hippuritic limestone.	320	......	Base not exposed.

"The finest sections are exposed in the Khirthar range in Upper Sind, and from this range the name applied to the Nummulitic limestone, which always forms the highest part of the hills, has been taken. On the eastern flank of the range, the Nari, Gáj, and Manchhar beds are seen successively dipping towards the Indus plain, whilst west of the range, in Kelat, lower beds come in; but these have hitherto only been examined very hurriedly in one spot, on the Gáj river, which traverses the main range by an impassable gorge. Some 10,000 feet of these lower beds are exposed, no base being seen; but Nummulitic and other fossils were only found in the higher beds, the lower 5000 or 6000 feet being unfossiliferous.

"The only other place in Sind where beds inferior to the Nummulitic limestone were found to be exposed is in the nameless range of hills running south from Sehwán. This range is sometimes spoken of as the Laki range, from the village of Laki near the northern extremity. It appears to be part of the Hála range of Vicary and others; but the Hála range of the old maps included the Khirthar and several other ranges, and no distinct chain of hills is known by any such name in the country. There is, however, an unimportant pass in the Laki range known as Hála Lak (Lak=pass). Each separate peak of this range has its own name, no general term being applied to the whole.

In this Laki range, however, beneath the Nummulitic limestone, the Lower Eocene and Cretaceous beds just noticed are well exposed.

"In the south-western portion of the province the well-marked breaks between the different subdivisions of the Tertiary series can no longer be traced. The massive Nummulitic limestone, so conspicuous to the northward, becomes broken up into thinner beds intercalated with clays and sands, and finally disappears, and the higher Tertiary groups all tend to pass into each other.

"The lowest bed seen in the province, the Hippuritic Limestone, has only been found in one spot, and there the outcrop does not occupy much more than about half a mile in length. The only recognizable fossil found was a Hippurite. It is probable that this limestone is identical with the Cretaceous limestone, which occupies a large area in Persia, and which has been traced at intervals, from south-east of Karmán to the neighbourhood of Tehrán. If so, this is the first time that the formation has been recognized in India, except in the Himalayas. The bed consists of pale-coloured hard limestone, very gritty and sandy above, purer beneath.

"Above the limestone there is a considerable thickness of dark-coloured sandstones, often of a purplish tint, and frequently rather calcareous. These beds are not very fossiliferous, but towards the top they contain oysters and a few bones, apparently reptilian."

* "The highest subdivision of the Cretaceous formation consists of soft olive shales and sandstones, usually of fine texture. The sandstone beds are thin, and frequently have the appearance of containing grains of decomposed basalt or some similar volcanic rock, or else fine volcanic ash. A few hard bands occur, and occasionally, but rarely, thin layers of dark olive or drab impure limestone. Gypsum is of common occurrence in the shales.

"*Palæontology.*—The olive shales are highly fossiliferous, the commonest fossil being *Cardita Beaumonti*, a peculiar, very globose species, truncated posteriorly, and most nearly allied to forms found in the lower and middle Cretaceous beds of Europe (Neocomian and Gault). This shell is extremely abundant in one bed, about 200 to 250 feet below the top of the Cretaceous series, but is not confined to this horizon. *Nautili* also occur, the commonest species closely resembling *N. Labechei* of Messrs. d'Archiac and Haime, but differing in the position of the siphuncle. This form appears undistinguishable from *N. Bouchardianus*, found in the upper Cretaceous Arialur beds of Pondicherry, and at a lower Cretaceous horizon in Europe. A second *Nautilus* resembles *N. subfleuriausianus*, another Eocene Sind species, in form, and is also allied to some Cretaceous types. Several Gasteropoda occur, especially forms of *Rostellaria*, *Cypræa*, *Natica*, and *Turritella*, but none are very characteristic. Two forms of *Ostrea* are common—one of them allied to the Tertiary *O. Flemingi* and to the Cretaceous *O. Zitteliana*, but distinct from both. The only mollusk which certainly passes into the Ranikot beds is *Corbula Harpa*. Two Echinoderms have been found—one is an *Epiaster*, an almost exclusively Cretaceous genus, only one or two Tertiary species having been found; the other is an aberrant form of *Echinolampas.* Two or three corals complete the list of invertebrate fossils found in the olive shales.

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* From 'A Manual of the Geology of India,' by Messrs. Medlicott and W. T. Blanford, F.G.S., vol. iii. p. 449; also Memoirs of the Geological Survey of India, vol. xvii. pt. 1; Blanford, Geology of Western Sind, 1879.

"In the lower part of the beds, with *Cardita Beaumonti,* however, some amphicœlian vertebræ were found, which Mr. Lydekker has ascertained to be crocodilian. All amphicœlian crocodiles are Mesozoic, and the present form must be one of the latest known. So far as it is possible to form an opinion from very fragmentary materials, the vertebræ in question appear more nearly allied to the Wealden *Suchosaurus* than to any other form hitherto described. It has, however, been already shown, when writing of the Gondwána flora, that the distribution of *Reptilia* in past ages was not the same in India as in Europe.

"*Deccan Trap.*—Mention has already been made of one bed of basalt intercalated in the sandstones above the hippuritic limestone; a much more important band of the same igneous rock has been traced, resting upon the *Cardita-Beaumonti* beds, throughout a distance of 22 miles from Ranikot to Jakhmari, about 17 miles south of Sehwán, wherever the base of the Ranikot group, the lowest Tertiary formation, is exposed. The thickness of this band of trap is trifling, and varies from about 40 to about 80 feet. Apparently in some places the whole band consists of two lava-flows similar in mineral character, except that the upper is somewhat ashy and contains scoriaceous fragments; the higher portion of each flow is amygdaloidal, and contains nodules of quartz, calcedony, and calcite, and in places the nodules are surrounded by green earth, as is so frequently the case in the Deccan traps.

"Another characteristic accessory mineral, common also in the traps of the Deccan and Malwa, is quartz with trihedral terminations. The basaltic trap of the Laki hills is apparently of subaërial origin, although it rests conformably on the marine (or estuarine?) *Cardita-Beaumonti* beds. There is nothing in the igneous bed to indicate its having consolidated otherwise than in the air, and the structure differs altogether from that of subaqueous volcanic tuffs.

"The evidence that this band of basaltic rock is interstratified, and not intrusive, is ample; throughout the whole distance the trap is found in precisely the same position between the lowest beds of the Ranikot group and the highest Cretaceous strata, and apparently perfectly conformable to both.

"*Ranikot Group.*—The name of the lowest Tertiary subdivision is derived from a hill-fortress of the Sind Amirs, situated in the Laki range of hills, and known as Rani-jo-kot, or Ranikot, and also as Mohan-kot, from the Mohan stream, which traverses the fortification. The Ranikot group is much more extensively developed in Sind than the underlying Cretaceous beds; for although it is confined to Lower Sind, and although its base is only seen in the Laki range, north of Ranikot, its upper strata occupy a considerable tract of country, about 26 miles long from north to south, by about 12 in breadth, north-west of Kotri; and another even larger exposure, about 36 miles long, occurs, extending from north of Jhirak (Jhirk, Jhirruk, Jerruck, or Jurruk) to Tatta. In the Laki range, the Ranikot beds are seen for about 35 miles; but the outcrop is never more than 2 or 3 miles broad, and one small inlier is exposed to the west of Ranikot.

"All the lower portion of the Ranikot group, including by far the greater portion of the beds, consists of soft sandstones, shales, and clays, often richly coloured and variegated with brown and red tints.

"Gypsum is of frequent occurrence; some of the shales are highly carbonaceous; and in one instance a bed of coal (or lignite) nearly 6 feet thick was found, and a considerable quantity of the mineral extracted. The quality was, however, poor; and from the quantity of iron-pyrites present, the coal decomposed rapidly, and was liable to spontaneous combustion when exposed, whilst the deposit was found to be a small patch, not extending more than about 100 yards in any direction. Some of the more pyritous shale is used in the manufacture of alum.

"The only fossils found in the lower portion of the Ranikot group, with the exception of a few fragments of bone, have been plants, some Dicotyledonous leaves, hitherto not identified, being the most important. All the Ranikot beds, except towards the top of the group, have the appearance of being of freshwater origin, and are probably fluviatile.

A variable portion of the group, however, towards the top, consists of highly fossiliferous marine limestones, often light or dark brown in colour, interstratified with sandstones, shales, clays, and ferruginous bands. These are the lowest beds in Sind containing a distinctly Tertiary marine fauna.

"The brown limestones are well developed around Lynyan, east of Band Vera and north-west of Kotri, and throughout the area of Ranikot beds, near Jhirak and Tatta. In this part of the country there appears to be a complete passage upwards into the overlying Nummulitic limestone (Khirthar); but in the Laki range the upper marine beds of the Ranikot group are poorly represented or wanting, and it is evident that they were removed by denudation before the deposition of the Khirthar limestone, for the latter is seen at Hothian Pass, resting upon their denuded edges.

"The greatest thickness of the Ranikot group in the Laki range (where alone, as has already been explained, the base of the group is visible), is about 2000 feet; but generally the amount is rather less, about 1500. It must, however, be recollected that in this locality some of the upper marine beds are wanting; and as these marine limestones and their intercalated shales, sandstones, &c., are 700 or 800 feet thick, in places north-west of Kotri, it is evident that the original development of the group exceeded the 2000 feet seen in the Laki range.

"*Palæontology.*—The following are some of the commonest or most important fossils of the Ranikot group. The largest collections made by the Geological Survey have as yet only been partially examined, and the lists of fossils given can be considered only preliminary, many of the commonest species being undescribed forms.

CEPHALOPODA.

Nautilus subfleuriausianus.
—— Deluci.
Nautilus Forbesi.

GASTEROPODA.

Rostellaria angistoma.
—— Prestwichi.
—— fusoides.
Terebellum distortum.
—— plicatum.
Voluta jugosa.
Natica longispira.
Nerita (Velates) Schmideliana.
Turritella angulata, var.
—— assimilis.

LAMELLIBRANCHIATA.

Corbula Harpa.
Vulsella legumen.
Spondylus Roualti.
Ostrea Flemingi.
—— vesicularis.

BRACHIOPODA.

Terebratula, *cf.* subrotunda.

ECHINODERMATA.

Schizaster, sp.
Hemiaster digonus.
Eurhodia Morrisi.
Prenaster, sp.
Toxobrissus, sp.
Conoclypeus, sp.
Echinolampas, *cf.* subsimilis.
Temnopleurus Valenciennesi.
Salenia, 2 sp.
Phymosoma, sp.
Porocidaris, sp. (spines).
Cidaris Halaensis.

ANTHOZOA.

Trochocyathus Vandenheckei.
Cyclolites Vicaryi.
Montlivaltia Jacquemonti.

FORAMINIFERA.

Operculina canalifera.
Nummulites spira.
Nummulites irregularis.
—— Leymeriei.

"In the above list the majority of forms, such as the Foraminifera, the majority of the Echinodermata and Gasteropoda, are Lower Tertiary; but still there is a very distinct admixture of species with Cretaceous affinities, such as the *Nautili*, all of which are connected rather with Cretaceous than with Tertiary types, the *Terebratula*, which cannot be distinguished from one of the commonest Upper Mesozoic species, and forms of *Salenia*, *Cyclolites*, &c. *Corbula Harpa* is the only form hitherto recognized that is also found in the Upper Cretaceous olive shales, but a variety of the same shell is also found in the Nari beds.

"*Khirthar Group.*—Although this group, named from the great frontier range of hills already noticed, is, when the underlying shales and sandstones are excluded, inferior in total thickness to several other subdivisions of the Tertiary series in Sind, it comprises by far the most conspicuous rock, the massive Nummulitic limestone. Of this formation all the higer ranges in Sind consist. It forms the crest of the Khirthar throughout, and all the higher portions of the Laki range, of the Bhit range south-west of Manchhar lake, and of several smaller ridges, and consists of a mass of limestone, varying in thickness from a few hundred feet in Lower Sind to about 1000 or 1200 at the Gáj river, and probably 2000 or even 3000 farther north.

"The colour is usually pale, either white or grey, sometimes, but less frequently, dark grey; the texture varies from hard, close, and homogeneous, breaking with a conchoidal fracture, to soft, coarse, and open. Ordinarily, the Nummulitic limestone is tolerably compact, but not crystalline, and is chiefly composed of Foraminifera, especially Nummulites, whole or fragmentary; corals, sea-urchins, and mollusks also abound, but the two latter very frequently only weather out as casts.

"It has already been mentioned that in the Laki range the Nummulitic limestone rests unconformably on the Ranikot group. The Khirthar group here cannot be much more than 500 or 600 feet thick, and consists entirely of limestone. To the south-east, towards Kotri and Tatta, there is no unconformity between the Ranikot and Khirthar groups; but, on the contrary, there is an almost complete passage between the two, and the limestone of the latter becomes much split up and intercalated with shales and sandy beds. To the south-west, near the Habb river, the massive limestone dies out altogether; and although it is well developed in the southernmost extremity of the Khirthar range near Karchát, about 50 miles south of Sehwán, it disappears entirely within a distance of 25 miles, and in the ranges on the Habb river is entirely replaced by shaly limestones, shales, and thick beds of sandstone. Some rather massive beds of nummulitiferous dark-grey limestone, very different in character from the pale coloured Khirthar limestone, are found west of the Habb, but their precise position in the series is not known; and the rocks appearing from beneath the Nari group, in the place of the Khirthar limestone, consist of shales and sandstones, with some calcareous bands abounding in Nummulites, and closely resembling, both in character and in the species of Foraminifera they contain, the Nummulitic shales beneath the massive limestones on the Gáj river. It is not known to what extent the typical Khirthar limestone is developed in Balúchistán; around Kelat, to the northward, this band appears to be extensively exposed; but to the westward, near Gwádar, the rocks supposed to represent the older Tertiary beds consist of an immense thickness of shales, shaly sandstones, and unfossiliferous calcareous bands, resembling the lower Khirthar of the Gáj and the beds of the Habb valley, and limestones with Nummulites are of unfrequent and local occurrence. It is thus evident that the Khirthar limestone, although it is so conspicuous in most parts of Sind, and although it attains a considerable thickness, is not by any means universally distributed.

"*Palæontology.*—The most characteristic fossils of the Khirthar group are *Nummulites* and *Alveolina*; neither the genera nor, as a rule, the species are peculiar; but the extraordinary abundance of individuals renders it usually easy to recognize even small fragments of the rock by the organisms preserved in it. The following is a list of the commonest or most important fossils:—

GASTEROPODA.

Ovulum Murchisoni, and other species.
Cerithium, *cf.* giganteum.
Nerita Schmideliana.

LAMELLIBRANCHIATA.

Pholadomya Halaensis.
Corbula subexarata.
Cardita mutabilis.
—— subcomplanata.
Lucina gigantea.
Astarte Hyderabadensis.
Crassatella Sindensis.
—— Halaensis.
Vulsella legumen.
Ostrea vesicularis, var. (O. globosa, *Sow.*).

ECHINODERMATA.

Brissopsis scutiformis.
—— Sowerbyi ?
Schizaster, sp.
Eupatagus Avellana.

Fibularia, sp.
Amblypygus, sp.
Conoclypeus pulvinatus.

Eurhodia Calderi.
Echinolampas discoideus.
—— Sindensis.

FORAMINIFERA.

Orbitolites pedunculata.
Orbitoides dispansa.
Patellina Cooki.
Alveolina ovoidea.
—— sphæroidea.
Nummulites obtusa.

Nummulites Ramondi.
—— Biaritzensis.
—— Beaumonti.
—— Vicaryi.
—— granulosa.
—— Leymeriei.

"Many of the species named, and the Foraminifera especially, are characteristically Eocene; and there can be no question that the Nummulitic limestone of India is a continuation of the same formation in Europe. Several species pass from the Ranikot beds into the Khirthar group; indeed the principal palæontological differences between the two may be due to a change in conditions, the Khirthar being apparently a deeper water deposit than the Ranikot group.

"*Nari Group.*—The series of Tertiary rocks above the Khirthar Nummulitic limestone is superbly developed and very well seen in the hills on the frontier of Upper Sind, the culminating ridge of which is known as the Khirthar. The names of the Tertiary groups overlying the Nummulitic formation have consequently been derived from places in this range; and the Nari group takes its title from a stream which traverses the lower portions of the range, composed almost entirely of Nari beds, for a considerable distance, and issues from the hills nearly west of Johi, and west by north of Sehwán. The present subdivision comprises, at the base, the uppermost bands of limestone containing *Nummulites*—the species, however (*N. Garansensis* and *N. sublævigata*), being distinct from those so commonly found in the Khirthar subdivision, and the limestone itself being usually distinguished from that of the Khirthar group by its yellowish-brown colour, and by being in comparatively thin bands, interstratified with shales and sandstones. Several other fossils, too, besides the Nummulites, differ from those in the Khirthar beds. Not unfrequently, however, there is an apparent passage from the white or greyish-white Khirthar limestone into the yellow or brown Nari rock, and the two groups appear always to be perfectly conformable; but no intermixture of the characteristic species of Nummulites has been detected, and the division between the Khirthar and Nari beds can always be recognized by the fossil evidence. In some places the lower Nari beds consist almost entirely of brown and yellow limestone; but more frequently the limestone bands are subordinate, dark shales and brown, rather thinly-bedded, sandstone forming the mass of the rocks. The limestone bands are often confined to the base of the group, and always diminish in abundance and thickness above, although they are occasionally found as much as 1500 feet above the top of Khirthar. The shales and fine sandstones, with occasional bands of limestone, constitute the lower Nari beds, and pass gradually into the coarser, massive, thick-bedded sandstones forming the greater portion of the group, and attaining a thickness of 4000 or 5000 feet on the flanks of the Khirthar range. With the sandstones, a few bands of clay, shale, or ironstone are interstratified, and bands of conglomerate occasionally occur. The Nari beds in their typical form extend throughout the eastern flank of the Khirthar range, and occupy a belt of varying width, from one or two to as much as 10 miles in breadth, between the underlying Khirthar and the overlying Gáj beds. On the western side of the Bhagotoro hills, 4 or 5 miles south of Sehwán, there is a break in the Nari beds, and some variegated shales, clays, and sandstones, richly tinted in parts with brown and red, and representing the massive sandstones of the upper Nari group, rest unconformably on the denuded edges of the lower Nari brown limestones and shales. The break is evidently local. To the east of the Laki range the Nari beds are entirely wanting, and it appears very possible that they have never been deposited in this portion of the Indus valley.

"From the neighbourhood of Sehwán to Jhirak, Manchhar beds rest, with more or less unconformity, on the Khirthar, a very faint and imperfect representative of the Gáj group occasionally intervening. But west of the Laki range, throughout Lower Sind, the Nari beds are found exposed almost wherever the base of the Gáj group is seen; they increase in thickness to the westward, and the Habb valley, from the spot where the river first forms the boundary of British territory to the sea, consists entirely of these strata. There is, however, in this part of the country no longer any such marked distinction between the subdivisions of the Tertiary series as is found in the Khirthar range. The disappearance of the Khirthar limestone has already been mentioned, and with it the lower Nari limestones with *Nummulites Garansensis* and *N. sublævigata* also disappear, so that it is no longer possible to draw a distinct line between the two groups, for the shaly beds at the base of the Naris are undistinguishable from similar rocks in the Khirthar. The calcareous shales, with the characteristic Khirthar Nummulites, below, and the massive Nari sandstones above, are still recognizable, and the two groups can consequently still be traced, although the dividing line between them is obscured. Beds of brown limestone, too, full of *Orbitoides papyracea* (or *O. Fortisi*), a fossil closely resembling a Nummulite, and associated in abundance with *N. Garansensis* in the typical lower Nari limestones, occur in the Nari beds of the Habb valley; but instead of being found at the base, they appear in the middle of the group. Again, just as at the base of the Nari beds, there is a difficulty in distinguishing them from the Khirthar, so the beds at the top of the former group can only be separated by an arbitrary line from the overlying Gáj beds.

"In the Khirthar range the upper boundary of the Nari group, although there is no unconformity, is distinct and definite, limestones with marine fossils of the Gáj group resting immediately upon the upper Nari sandstones. But in Southern Sind bands of limestones, or calcareous sandstones, with marine fossils, some of which are well-marked Gáj species, occur in the upper part of the Nari group, whilst limestone bands with the Nari *Orbitoides papyracea* are found in the Gáj.

"*Palæontology.*—The sandstones, which form so large a portion of the Nari group, have hitherto proved destitute of animal remains, and in the typical area in Upper Sind no beds with marine fossils are intercalated in the upper portion of the group; but the occasional interstratifications of shales and clays often contain fragments of plants, and some ill-marked impressions, probably due to fucoids, have been found in the sandstones themselves. There appears a probability that these sandstones may be of fluviatile and not of marine origin.

"In the limestones towards the base of the Nari group many marine fossils have been obtained, the following being some of the more important:—

GASTEROPODA.

Terebellum obtusum.
Cypræa nasuta.
Voluta jugosa.
—— dentata.
Triton Davidsoni.
Natica patula.
Natica sigaretina.
Siliquaria Granti.
Solarium affine.
Trochus cumulans.
Phasianella Oweni.

LAMELLIBRANCHIATA.

Corbula Harpa.
Pecten Labadyei.
Venus granosa.
Cardium triforme.
Ostrea flabellula.

ECHINODERMATA.

Schizaster Beluchistanensis.
Eupatagus rostratus.
Echinolampas, sp.
Clypeaster profundus.
Cœlopleurus Forbesi.
Cidaris Verneuilli.

ANTHOZOA.

Trochocyathus Burnesi.
Montlivaltia Vignei.

FORAMINIFERA.

Nummulites Garansensis.
—— sublævigata.
Orbitoides papyracea.

"Although some species pass from the Khirthar and even from the Ranikot group into the Nari beds, the fauna is chiefly distinct, and marks a higher horizon. The most marked change is, perhaps, in the Foraminifera, because they are so abundant and characteristic—whole beds of limestone towards the base of the Nari group being entirely made up of *Nummulites Garansensis*, *N. sublævigata*, and *Orbitoides papyracea*, the last-named frequently of large size, some specimens being two or three inches in diameter; yet every species is distinct from those occurring in the Khirthar group. One of these species of *Nummulites*, *N. Garansensis*, is of importance, because it occurs in Europe, as in Sind, in the highest strata characterized by the abundance of the genus, those beds being at the base of the Miocene. *Nummulites sublævigata* is peculiar, so far as is known, to India.

"Several of the Mollusca and Echinodermata of the Nari beds also, such as *Siliquaria Granti*, *Solarium affine*, *Venus granosa*, and *Clypeaster profundus*, show distinctly Miocene affinities, and some of these pass up into the Gáj group. But at the same time there are so many Eocene forms present, such as *Natica patula*, *N. sigaretina*, *Ostrea flabellula*, *Voluta jugosa*, &c., that it is somewhat difficult to decide to which subdivision the Nari beds should be assigned. They may, perhaps, occupy an intermediate position, similar to that of the Oligocene of continental geologists.

"*Gáj Group.*—Upon the Nari group, almost throughout Sind, there is found resting a mass of highly fossiliferous limestones and calcareous beds, usually more or less shaly, always distinctly stratified, and easily distinguished from the limestones of the older Tertiary formations by the absence of Nummulites. A superb section of the strata forming this group is exposed on the banks of the Gáj river, the only stream which cuts its way through the Khirthar range, and in the neighbourhood of which, west of the range, the fine section of Lower Tertiary and Cretaceous beds, already noticed, is exposed. From this river the present group derives its name.

"On the eastern flanks of the Khirthar range, in Upper Sind, the Gáj group forms a conspicuous ridge, the hard dark-brown limestone bands near the base of the formation resisting the action of denudation far more than the soft sandstones of the Nari beds, and rising every here and there into peaks of 1000 and 1500 feet, or even more, escarped to the westward, and sloping to the east, Amru (the highest summit of the Gáj ridge) being 2700 feet above the sea. Still the limestone bands, although so conspicuous, are subordinate, the greater part of the group consisting of sandy shales, clays with gypsum, and, towards the base, sandstones. Many of the bands of limestones appear very constant in position, and may be traced for a long distance. As a rule, they are dark brown in colour; but one bed is white, and abounds in corals and small Foraminifera (*Orbitoides*), whilst some of the darker bands contain Echinodermata in large quantities. The uppermost portion of the group is usually argillaceous, being chiefly composed of red and olive clays with white gypsum; and these beds pass gradually into precisely similar strata belonging to the overlying Manchhar group. The passage-beds contain, amongst other fossils, *Turritella angulata* and forms of *Ostrea* and *Placuna*, and the following:—

Corbula trigonalis.
Lucina (Diplodonta) incerta.

Tellina subdonacialis.
Arca Larkanensis.

"All of these have allies living in estuaries at the present day, *Arca granosa*, a recent representative of *A. Larkanensis*, being one of the commonest and most typical of Indian estuarine Mollusca. To these estuarine passage-beds further reference will be made presently, when the relations of the Manchhar to the Gáj beds are discussed. The Gáj beds at the Gáj river are very nearly 1500 feet thick; but they appear to be less developed to the northward in the Khirthar range, and not to be much more than half the thickness named west of Lárkána, where, however, they are nearly vertical, and have probably suffered from pressure. In Lower Sind the Gáj group, like the Nari, disappears to the eastward of the Laki range, where it is either entirely wanting or else represented by a thin band, containing one of the characteristic fossils, *Ostrea multicostata*, at the base of the Manchhar group. There is, however, a very large area of Gáj beds north and north-east of Karáchi; and the appearance of the formation there is somewhat different from what it is in the Khirthar range; for the greater portion of the group consists of pale-coloured limestones, almost horizontal, or dipping at very low angles, and to the east of the Habb valley forming plateaux 400 or 500 feet high, bounded by steep scarps, which rise from the low ground of the soft Nari sandstones.

A low range of hills, formed of Gáj beds, extends to the south-west, past the hot springs at Magar or Mangah Pír, to the end of the promontory known as Cape Monze, west of Karáchi; and the same beds form the low hills east and north-east of the town, and furnish the materials of which the houses in Karáchi are mostly built. A small island called Churna, in the sea west of Cape Monze, also consists of Gáj rocks. To the northward, the Gáj area of Lower Sind extends with very irregular outline to the neighbourhood of Tong and Karchat, almost due west of Hála; and there are several outliers farther north, connecting the southern portion of the group with the typical outcrop in the Khirthar range. East of Karáchi, also, Gáj beds extend in the direction of Tatta until they disappear with the other Tertiary rocks beneath the alluvium of the Indus. As was shown in a previous Chapter, the Gáj group of Sind appears to be represented in Cutch by a highly fossiliferous belt, containing most of the typical mollusca, echinoderms, &c. It is quite possible that the present group, as well as the Nari, never was deposited in the neighbourhood of Kotri and Jhirak.

"It has been already stated that the Gáj beds, throughout the greater portion of the Khirthar range, rest conformably upon the Nari group, although there is a change in mineral character, and that, in Lower Sind, the passage from one group into the other is gradual, calcareous bands, with Gáj fossils (such as *Ostrea multicostata* and *Pecten subcorneus*), being found interstratified with the uppermost Nari sandstones. At one place, however, near Tandra Ráhim Khán, west by north of Sehwán, the outcrop of the Gáj beds, here dipping at a high angle to the westward, runs nearly in a straight line across the mouth of a valley, composed of a deep synclinal of the Nari group, between two anticlinal ridges of Khirthar limestone. As the Gáj beds do not share the synclinal curve of the Naris, it is difficult to see how the two can be conformable; but an examination of the boundary between the two groups failed to show any clear evidence of unconformity. There are, however, some places south of Sehwán where the Gáj group overlaps the Nari beds and rests upon the Khirthar limestones; but it must be recollected that the Gáj group is itself overlapped by Manchhar beds in the immediate neighbourhood. The commonest and most characteristic fossils of this group are *Ostrea multicostata* and *Breynia carinata.* There cannot be any question that the Gáj fauna is newer than Eocene: some of the species are recent (for instance, *Dosinia pseudoargus* is identical with the recent *D. exasperata,* Chemn.); and it is probable that many others, when they are compared with recent forms more carefully than has hitherto been done, will prove to be the same as living species. Several genera, too, as *Maretia, Breynia, Meoma, Echinodiscus, Cladocora,* and *Echinopora,* are rare or unknown in the older Tertiaries; and there is almost a complete disappearance of Eocene forms, very few species being common to the Nari beds even. The chief doubt is whether the Gáj should not be considered as Upper Miocene. The only mammal yet obtained from the Gáj beds is *Rhinoceros Sivalensis,* a species found also in the Siwaliks."

IV. *The Classification followed and the Works consulted.*

The classification followed in this Monograph of the fossil Corals of Sind is principally in accordance with that of MM. Milne-Edwards and Jules Haime, and contained in their 'Histoire Naturelle des Coralliaires.' Some modifications have been used, which have been the result of the experience of zoophytologists since that book was published; but the attempt has been made to restrict, rather than multiply, genera. The other works which have been constantly used in the preparation of this Monograph are:—those volumes of the Palæontographical Society which relate to Mesozoic and Tertiary British Corals; the works of Fromentel on French Zoophytology, and the descriptions of Catullo; and D'Achiardi's works on the fossil Corals of the Nummulitic strata of the Venetian Alps ('Studio comparativo fra i Coralli dei Terreni Terziari del Piemonte e dell' Alpi venete,' Pisa, 1868).

Especial thanks are due to the late A. E. Reuss, whose clear descriptions and beautiful engravings facilitate the labour of every student of fossil corals. His works which relate to the present subject are:—'Die fossilen Foraminiferen, Bryozoen, und Anthozoen von Oberburg in Steiermark,' from the 'Denkschriften der kaiserlichen Akademie der Wissenschaften in Wien,' 1864; also, from the same source, "Paläontologische Studien über die älteren Tertiärschichten der Alpen:—1. Die fossilen Anthozoen der Schichten von Castelgomberto, 1868; 2. Die fossilen Anthozoen und Bryozoen der Schichtengruppe von Crosara, 1869; 3. Die fossilen Anthozoen von S. Giovanni Ilarione und von Ronca, 1874." My paper on the fossil Corals of the older Tertiaries of the West Indies, contained in the 'Quarterly Journal of the Geological Society' (1873, vol. xxix.), and, finally, D'Achiardi's admirable work 'Coralli eocenici del Friuli' (Pisa, 1875) have been of much service.

V. *The Characteristic Growth of the Sind Corals and their Range in Time.*

The condition of the specimens collected by the Geological Survey of India from the strata in Sind is good, and, as a rule, the external characters of the species were readily investigated; but a few sections were required; and all doubtful specimens, or those which did not fairly indicate structure, were neglected.

The predominance of pedunculated forms with a well-developed epitheca is very remarkable in the whole of the series. The younger forms were very constantly preserved fixed to a nummulite, and the older were crammed with these Foraminifera in the Ranikot and Khirthar specimens.

The Corals grew in a shallow sea, crowded with Nummulites, in the ages during the accumulation of the sediments of these two series. In the Cretaceous age, when the olive sandstones beneath the Trap accumulated, there were no Nummulites, but a shallow sea prevailed. The Cretaceous Corals appear to have lived under circumstances preventing the formation of a continuous coral limestone.

There are many Corals which may have belonged to the top of the Khirthar or to the bottom of the Nari series; and in the Nari beds the Oligocene coral-fauna prevailed.

But in the Gáj series, although pedunculate Corals prevail, others occur which were massive during life, and the assemblage was more reef-like than the others in its generic peculiarities.

The Corals form five very natural faunas, and that of each geological series is separable from the others, community of species being exceptional: the Cretaceous, Nummulitic, Upper Nummulitic, Oligocene, and Miocene series are represented.

VI. *Description of the Fossil Corals from the Strata below the Trap in Sind.*

THE CRETACEOUS SERIES.

List of Species described.

From the strata below the Trap and containing *Cardita Beaumonti.*

Section **MADREPORARIA.**

Group MADREPORARIA APOROSA.

Family TURBINOLIDÆ.

Subfamily CARYOPHYLLIACEÆ.

Genus CARYOPHYLLIA (as limited by Stokes, Zool. Journ. vol. iii. p. 481, 1828).

Caryophyllia compressa, *Duncan.*
——— indica, *Duncan.*
——— Feddeni, *Duncan.*

Subfamily TROCHOCYATHACEÆ.

Genus TROCHOCYATHUS, *M. Edwards & J. Haime, Hist. Nat. des Corall.* vol. ii. p. 26.

Trochocyathus Lakii, *Duncan.*

Subfamily TURBINOLIACEÆ.

Genus SMILOTROCHUS, *M. Edwards & J. Haime, tom. cit.* p. 70 (amended).

Smilotrochus Jakhmari, *Duncan.*
——— Blanfordi, *Duncan.*

Family OCULINIDÆ.

Transition-Group STYLOPHORINÆ.

Genus STYLOPHORA.

Stylophora, species.

Family ASTRÆIDÆ.

Subfamily LITHOPHYLLIACEÆ CÆSPITOSÆ.

Genus RHABDOPHYLLIA, *M. Edwards & J. Haime, tom. cit.* p. 343.

Rhabdophyllia Barkii, *Duncan.*

Group MADREPORARIA PERFORATA.

Family PORITIDÆ.

Genus LITHARÆA, *M. Edwards & J. Haime, op. cit.* vol. iii. p. 187.

Litharæa epithecata, *Duncan.*
——— epithecata, var. hemisphærica.

The fossil Corals collected by Mr. Fedden, F.G.S., of the Geological Survey of India, from beds beneath the Trap underlying the Nummulitic series of Sind, were obtained from Jakhmari, in the Laki range, south-west of Amri, and from Barki nala, north of Ranikot, in the Laki range. Their general position has been noticed in a former page, and they are found in the Olive sandstones and in a more recent geological horizon than that of the Hippurite limestone. The fossils are usually well preserved, are calcareous, and their surfaces are of a light-brown tint. Usually dark calcite has replaced the hard parts of the corals deeply.

The fossil Corals belong to the Madreporaria aporosa and to the Madreporaria perforata—the first group being represented by the genera *Caryophyllia*, *Trochocyathus*, *Smilotrochus*, and *Rhabdophyllia*, and the last by the genus *Litharæa*.

None of the forms of Corals described by MM. d'Archiac and Haime in their classical work are found in the Cretaceous series.

Section **MADREPORARIA.**

Group MADREPORARIA APOROSA, *Milne-Edwards & Jules Haime.*

Family TURBINOLIDÆ.

Subfamily CARYOPHYLLIACEÆ.

Genus CARYOPHYLLIA, *Stokes* (limited).

1. Caryophyllia compressa, *Duncan*. Plate I, Figs. 1–4.

The corallum is compressed from side to side, slightly bent in the plane of the minor axis, adherent to a foreign body by a small oval base. The calice is elliptical in outline and rather pointed at the extremities. The costæ are distinct from the base upwards, alternately large and small, becoming more subequal at the calice, blunt, rather largely granular and rather close; those at the extremity of the calice are the largest. The calice is shallow; the columella is large; the septa are alternately long, stout, sharply granulated at the sides, and small, the smallest being much thinner than the corresponding costæ. There are four cycles of septa, complete in six systems; and there are short pali before the tertiary septa.

Height of corallum $\frac{5}{10}$ inch.

Length of calice $\frac{7}{20}$ inch; breadth of calice $\frac{5}{20}$ inch.

Locality. Jakhmari, Laki range, west of Amri. Survey-number G $\frac{280}{137}$.

Illustrations of the Species in Plate I.

Fig. 1. Side view of the corallum.
2. View of part of a calice: magnified.
3. The base: natural size.
4. Costæ near the calice: magnified.

2. Caryophyllia Indica, *Duncan*. Plate I, Figs. 5–7.

The corallum is conical, truncate, and nearly straight. The calice is circular in outline, widely open, and the fossa is shallow. The base is small, circular, and blunt. There are four cycles of septa in six systems, and there is not much difference in the size of the first and second orders, which are the longest and largest; the tertiaries are smaller and not so long, and the highest orders are linear and short; they are all linear within, granular, not exsert, and correspond to costæ larger than their bases, especially as regards the higher orders. Pali exist before the tertiary septa; they are distant from the septa, and small. The columella is small, and its tissue very lax and wide apart. The costæ are subequal, distinct to the base, granular at the edge and sides, the epitheca being rudimentary there. Near the base the costæ of the higher orders are the smallest.

Height of the corallum $\frac{4}{10}$ inch.

Breadth of calice $\frac{4}{10}$ inch.

Locality. Barkinala, north of Ranikot, Laki range. Survey-number G $\frac{286}{135}$ and G $\frac{304}{30}$.

Illustrations of the Species in Plate I.

Fig. 5. A side view of the corallum.
6. The calice: magnified.
7. The costæ: magnified.

There is a variety with small moniliform costæ near the base.

Locality. Barki nala, north of Ranikot, Laki range. Survey-number G $\frac{304}{30}$.

3. Caryophyllia Feddeni, *Duncan.* Plate I, Figs. 8–10.

The corallum is tall, slender, not quite straight, marked with growth-rings, and the calice is circular in outline. The base has a small scar. The costæ are alternately large and small below, less unequal above, wavy, distinct, multigranular above, and some are small and moniliform near the base. The calice is small, and the columella excessively so. The pali are small and few in number, and are before the third septa when the system is complete. The septa are unequal, the primaries large, and the higher orders much smaller than their costæ. The septa are long and distant, and there are four incomplete cycles of them.

Height of the corallum $\frac{6}{10}$ inch.

Breadth of calice $\frac{3}{10}$ inch.

Locality. Jakhmari and Barki nala. Survey-numbers G $\frac{280}{137}$, G $\frac{280}{138}$, G $\frac{304}{30}$.

Illustrations of the Species in Plate I.

Fig. 8. A side view of the corallum.
9. Costæ, magnified, from below.
10. Portion of the calice: magnified.

Subfamily TROCHOCYATHACEÆ.

Genus TROCHOCYATHUS, *M. Ed. & Haime.*

1. Trochocyathus Lakii, *Duncan.* Plate I, Figs. 11–13.

The corallum is short, turbinate, with a circular calice, and a small scar of former attachment at the base. The septa are in four cycles, incompletely developed, an order being missing in one or two half-systems; they are slightly exsert, granular, and not very close; those of the first and second cycles are equal and are the longest. The pali are small, unilobed and are before the first, second, and third septa. The columella is small. The costæ are large, strong, projecting, multigranular, alternately large and very small; but there are exceptions. The smaller costæ are largely and roundly granulated, in single series, and some exist from the base, and the others come in far up.

Height of the corallum $\frac{3}{10}$ inch.

Breadth of calice $\frac{2}{10}$ inch.

Locality. Jakhmari, Laki range, south-west of Amri. Survey-number G $\frac{280}{137}$.

Illustrations of the Species in Plate I.

Fig. 11. The coral: natural size.
12. The calice: magnified.
13. A part of the calice: magnified, and more or less as a diagram.

Subfamily TURBINOLIACEÆ.

Genus SMILOTROCHUS.

Smilotrochus, *M. Ed. & J. Haime, Hist. Nat. des Corall.* vol. ii.

This genus, as noticed in Brit. Foss. Corals, Palæont. Soc. 1869, p. 19, by P. M. Duncan, is the simplest type of coral, there being only wall, costæ, and septa present. A non-generic attribute was admitted in the diagnosis by MM. Milne-Edwards and Jules Haime, namely, that the corallum had no trace of former adhesion. This is now omitted, for several corals from Sind have clearly Smilotrochoid peculiarities, but also present traces of former adhesion to foreign bodies. I have shown, in the description of the Madreporaria dredged up in the expedition of H.M.S. 'Porcupine' (Trans. Zool. Soc. Lond. vol. viii. p. 309), that in the genus *Caryophyllia* broad surfaces of adhesion, smaller pedunculate scars, and perfectly free bases are consistent with specific identity. Hence the former state of adhesion or not has no generic value; for an adherent coral may become non-adherent with age, and may lose every trace of its former state.

1. SMILOTROCHUS JAKHMARI, *Duncan.* Plate I, Figs. 14–17.

The corallum is tall and conical, with a circular, widely open calice, and a small base adhering to a shell; it is also slightly curved or nearly straight, and is marked with lines of growth. The septa are in four cycles in six systems, and are very slightly exsert; those of the higher orders are less prominent and smaller than the others, and all are minutely granular, even on the free margin. The costæ are well developed, narrow, alternately large and small; and these last are minute in some places, and have a single row of distinct granulations on them; the others, much larger, are granular and wavy.

Height of the corallum $\frac{6}{10}$ inch.

Breadth of calice $\frac{4}{10}$ inch.

Locality. Jakhmari, Laki range, south-west of Amri. Survey-number G $\frac{280}{137}$.

Illustrations of the Species in Plate I.

Fig. 14. The corallum: natural size.
15. Costæ: magnified.

A second specimen has the corallum straight.

Height of the corallum $\frac{6}{10}$ inch.

Breadth of the calice $\frac{3}{10}$ inch.

Locality. Barki nala, north of Ranikot, Laki range. Survey-number G $\frac{304}{130}$.

Illustrations of the Species in Plate I.

Fig. 16. Side view of the corallum.
17. Costæ: magnified.

2. Smilotrochus Blanfordi, *Duncan.* Plate I, Figs. 18–21.

The corallum is tall, wedge-shaped, greatly compressed, presents a very small oval scar of former adhesion at the base, and is more or less bent; it has a long, narrow, shallow calice, which is horizontal, the margins being wavy, and the rounded sides of the corallum form an angle at the base of from 30° to 45°. Marked with growth-rings, which often resemble a linear epitheca; the outside has very numerous small costæ, which project but little, are narrow, alternately large and small, and one in every four is the largest. An indistinct broad, flat granulation exists on them. The central fossa of the long, elliptical calice is linear and deep. The septa are about 200 in number, and in large calices they are arranged as multitudes of little systems of fours and twos; they are short, unequal, straight, sometimes exsert, but not invariably, and those nearest the centre have a small swelling at their inner end.

Near the base, in large specimens, transverse sections show that some of the large septal ends unite side by side to form a false columella with an axial space; higher up this does not take place. There are no dissepiments.

Height of the corallum $\frac{6}{10}$ to $\frac{8}{10}$ inch.

Length of the calice about 1 inch; breadth of the calice not quite $\frac{3}{10}$ inch.

Locality. Cardita-Beaumonti beds, Bárah, Laki range. Survey-number G $\frac{304}{32}$.

The specimens are crowded together in a fine sandy matrix of a light brown tint, reddish on wetting, and are in a perfect condition. There are evidently no pali, endothecal structures, or true columella; and the genus is therefore *Smilotrochus.* In shape it recalls *Trochocyathus Van den Heckei,* Ed. & H., when it is not bilobed; and it has no affinities with any European Cretaceous form, being very Eocene in its facies.

Illustrations of the Species in Plate I.

Fig. 18. Side view of the corallum: natural size.
19. The calice: natural size.
20. Costæ: magnified.
21. Part of the calice: magnified.

A young coral of the genus *Smilotrochus*, probably belonging to this species, is amongst the collection.

Fig. 22. Side view of young corallum.
23. The costæ, magnified, showing alternate large and small costæ.

This genus received many new species during the description of the Lower Cretaceous Corals of England by myself, and they rather abound in the Upper Greensand and Gault; but the shape of the coral and the details of the costæ would distinguish the Indian forms.

MM. Milne-Edwards and Haime describe and figure a species from the Upper Greensand horizon of Farringdon, called *Smilotrochus Austeni*, which has greater affinities than any other with the Indian forms; and they state that *Smilotrochus Hagenowi*, which they neither describe nor delineate, only differs from *Smilotrochus Austeni* by its less numerous and subflexuous costæ. It is from the Maestricht Chalk.

Family OCULINIDÆ.

Transition-Group STYLOPHORINÆ.

Genus STYLOPHORA.

Stylophora, *M. Ed. & J. Haime, Hist. Nat. des Corall.* vol. ii. p. 133.

1. **Stylophora** species. Plate III, Fig. 15.

A portion of a terminal branch of a *Stylophora*, with numerous calices, some close, and others separated by a small amount of cœnenchyma, which is plain. The costæ are slightly prominent; the septa, twelve in number, are small, six being the largest, and the columella is small. It is quite possible that it may be one of the *Stylophora-contorta*, Leymerie, group, which is elsewhere found in the Nummulitic series.

The genus is largely represented in the Tertiary and Recent formations of Europe and of the West Indies.

The specimen is on the same block as *Smilotrochus Blanfordi*.

From Bárah, Laki range.

Family ASTRÆIDÆ.

Subfamily LITHOPHYLLIACEÆ CÆSPITOSÆ.

Genus RHABDOPHYLLIA.

Rhabdophyllia, *M. Ed. & J. Haime, Hist. Nat. des Corall.* vol. ii. p. 342.

The corallum is in the form of a branching bush. The corallites are long and subcylindrical; their walls are naked, and present along their whole length distinct granular costæ. The contour of the calices is irregular; the columella is spongy and well developed; the septa are short, and the endotheca is scanty.

This diagnosis embraces many species of the Triassic, Jurassic, Cretaceous, and

Eocene ages; and four fragments of a corallum, or of similar coralla, were found in the Laki range.

1. Rhabdophyllia Barkii, *Duncan*. Plate I, Figs. 24–28.

The corallites are short, compressed, often bent, and marked transversely by contractions and enlargements; and the costæ are wide apart, narrow, projecting, granular, and long. The intercostal spaces are wide, minutely granular, and often contain a small costa. The wall is thin, and the calice is longer than broad or irregularly shaped. The septa are long and slender, and the higher orders are very small. Each costa at the calicular margin corresponds with a septum; and the smallest septa arise from an intercostal space or from a new and rudimentary costa. The full number of septa is 48; but the third cycle is not always completed.

The columella occupies some space, and is made up of lax and distant trabeculæ connected with the ends of the septa. The septa are not over straight, and the larger are rather distant. The endotheca is extremely scanty.

Length of largest piece $\frac{7}{10}$ inch.

Breadth of calice $\frac{3}{10}$, and length nearly $\frac{5}{10}$ inch.

Locality. Barki nala, north of Ranikot, Laki range. Survey-number G $\frac{226}{136}$.

Illustrations of the Species in Plate I.

Fig. 24. A fractured part: magnified.
25 & 26. Specimens, side view: natural size.
27. A calice: magnified.
28. Costæ: magnified.

Group MADREPORARIA PERFORATA, *Milne-Edwards & Jules Haime*, 1850.

Family PORITIDÆ, M. Ed. & J. Haime, Hist. Nat. des Corall. vol. iii. p. 89.

Genus LITHARÆA, *M. Ed. & Haime.*

Astræa (pars), *Defrance; Goldfuss; Michelin.*
Litharæa, *M. Ed. & J. Haime, Compt. Rendus*, t. xxix. p. 258 (1849); *Monogr. des Poritides*, p. 35.
Siderastræa (pars), *Lonsdale.*

This genus has the walls between the close corallites perforate or made up of trabeculæ instead of a solid plate, as in the genus *Isastræa* for instance; consequently in some places, in every species and generally in most, a good amount of reticulate tissue exists on the surface between the margins of the polygonal calices. The septa, where they spring from the wall, are more or less perforate; but elsewhere they are thin, solid plates, some of which reach the columella. The calices are never very deep, and their centre is filled up by the top of the columella, which is composed of lax trabeculæ, continuous with the septal ends. The distinguished authors of the genus consider that there is a thin or a rudimentary epitheca present; and they introduce into the generic diagnosis some points which are more specific than generic—such as the statement that there are usually three cycles of septa, and that the upper edge of the septa is deeply crenulate.

They distinguished the typical characters in the *Astræa Websteri* of Bowerbank, or *Siderastræa* of Lonsdale, a fossil found in the Bracklesham-Bay series. A dendroid form was described by them from the Miocene of Dax; a convex and free species, the old *Astræa crispa* of Michelin, was noticed from the Lower Eocene of Cuise-la-Motte; and a most interesting one was alluded to as having been found, with a well-developed and stoutly folded epitheca, in the Upper Chalk of Maestricht.

It is evident that, as in most compound corals, there was much diversity of growth, and that convex, free, and epithecated kinds could come within the generic diagnosis.

Since the publication of the 'Hist. Nat. des Corall.' many species have been added to those there noticed, and the genus stands as a good one.

Reuss has described a species (*Litharæa affinis*) from the Tertiaries of Java*; D'Achiardi has noticed it amongst the Eocene at Friuli†; and a well-marked form was described from the Oligocene deposit at Brockenhurst‡. Recent species are not known.

1. LITHARÆA EPITHECATA, *Duncan*. Plate II, Figs. 1–9.

The corallum is circular in outline, broad, short, more or less convex above and flat or concave inferiorly, where there is a well-developed epitheca marked with concentric grooves and elevations.

The calices are rather irregular in shape, and are usually hexagonal in outline; they are close, and but little trabeculate wall is between them. Widely open, they are shallow; and whilst large and subequal on the greater part of the corallum, they are smaller and of different sizes close to the thin rim of the full-grown coralla. There are three cycles of septa; all are distant, ragged, not over straight, with enlargements and points on their sides, and incised, and bluntly crenulate or moniliform, on the free edge; they are trabeculate near the wall, and are united within by trabeculæ here and there. The septa are slender and long; the primaries and secondaries are subequal; the tertiaries join the secondaries, being curved.

The columella is small, and is composed of distant and contorted trabeculæ.

Beneath the epitheca, the lower edges of the septa and trabeculæ form a close radial series, which simulates a costal arrangement. A small central projection occurs on the base, indicating the position of the first calice above.

Diameter of the largest specimen 3 inches; thickness of the largest specimen $\frac{2}{10}$ inch.

Breadth of central calices $\frac{1}{4}$ inch; breadth of marginal calices $\frac{2}{10}$ inch.

Locality. Jakhmari, Laki range, south-west of Amri. Survey-number G $\frac{280}{137}$.

Position. In beds with *Cardita Beaumonti.*

Numerous specimens exist of this very characteristic form, and they were found of many dimensions. In all the basal epitheca is a most striking feature; and, except when altered by fossilization, the trabecular walls and septa are sufficient to distinguish the species from any member of the genus *Isastræa* at once. In some specimens the calices are deeper than in others, and the margins of the calices are unequally elevated, whilst the whole surface is gibbous here and there. The sameness of size of the calices in the same specimen is sometimes striking.

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* A. E. Reuss, 'Fossile Korallen von der Insel Java' (Novara Exped.).

† D'Achiardi, 'Coralli Eocenici' (Pisa, 1875).

‡ P. M. Duncan, 'Supp. Brit. Foss. Corals,' Pal. Soc. Lond. vol. xix.

The young forms have a flat base; and this appears to grow more or less dome-shaped with increasing lateral dimension, and probably the original calice started with a minute peduncle and epitheca. Growth appears to take place by budding just on the outer margin of the calices; and no upward development occurs, there being but one row of calices in vertical measurement.

In some of the fossils the base has become covered with a mud containing fossils, and then the specimen appears to be an incrusting form; but with a little care the epitheca can be distinguished. It is this basal epitheca that gives the species its especial character; and it is a remarkable fact that Jules Haime should have noticed an epitheca only in an Upper Cretaceous species from Maestricht *. None of the Tertiary forms have it.

The weathering of the surface brings out the perforate condition of the walls and septa; and some forms of fossilization, especially an infiltration with calcite, by filling up the interstices, render the form like an *Isastræa* with a small columella. When destruction of the original coral has taken place, only portions of it being left here and there, the cast that remains has, of course, no evidence of the former presence of the wall between the calices, and the aspect given is that of an Heliastræan. It is necessary to remember this; for some specimens from Barki nala might be relegated to another genus than *Litharæa*.

LITHARÆA EPITHECATA, *nobis*, var. HEMISPHÆRICA. Plate II, Fig. 10.

The basal surface is concave, and the upper surface is almost hemispherical. The calices are shallow, and hence there must be a vertical successional growth.

Breadth of corallum $1\frac{1}{10}$ inch; height centrally $\frac{6}{10}$ inch.

Locality. Barki nala. Survey-number G $\frac{266}{138}$.

When the fossilization has destroyed the walls, the remarks already made hold good; but towards the edges some smaller calices show all the specific characters.

Illustrations of the Species in Plate II.

Fig. 1. The upper surface of the type of *Litharæa epithecata.*
2. The basal epitheca.
3. A smaller and younger specimen; calicular surface.
4. The basal surface.
5. The basal epitheca of a very small specimen.
6. Calices of a weathered specimen: natural size.
7. The calices: magnified.
8. The structure of the wall, septa, and endotheca: magnified.
9. A portion of the basal epitheca: magnified.
10. View of the variety *hemisphærica.*

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* *L. Goldfussi*, M. Ed. & J. H., Hist. Nat. des Corall. iii. p. 189.

List of the Species of Madreporaria from the beds with *Cardita Beaumonti* at Jakhmari, at Barki nala, north of Ranikot, and at Bárah, in the Laki range.

1. *Caryophyllia compressa*, Duncan.
2. *Caryophyllia Indica*, „
3. *Caryophyllia Feddeni*, „
4. *Trochocyathus Lakii*, „
5. *Smilotrochus Jakhmari*, „
6. *Smilotrochus Blanfordi*, „
7. *Rhabdophyllia Barkii*, „
8. *Litharæa epithecata*, Duncan, and a variety.
9. *Stylophora*, sp.

Of these corals the most numerous are the *Litharææ*, and the species is evidently a most characteristic form. The *Caryophylliæ* are next in importance, and then the *Smilotrochi*.

Taken as a fauna, this assemblage of species does not indicate the conditions of a reef sufficient to form a coral-limestone. The forms were not massive, and the *Litharæa* was epithecate and covered a very small area. A shallow-sea formation, where the corals lived under not very favourable conditions, occurred.

With regard to the alliance of the corals with those of other strata and formations, but little can be determined. There are no characteristic Secondary or Tertiary forms present. The range of the genus *Caryophyllia* is from the Cretaceous to the present day, and the new species do not belong to the deep-sea group of the European Chalk. The genus *Smilotrochus* was most common in the Upper Greensand and Gault of Europe; but it lasted on into the Nummulitic, and may be still represented. The *Smilotrochi* have thus as great Nummulitic as Cretaceous affinities. The *Litharæa* has affinities with an Upper Cretaceous form, but the genus had a great Tertiary range.

As a whole, the facies of the fauna is more Eocene than Cretaceous; and it is impossible to give a geological position, so far as age is concerned, to the group of forms from this limited palæontology. There is a remarkable similarity of outline, figure, and of special shapes of certain species in the coral-faunas of the Cretaceous and Eocene ages; and from the appearance of the *Stylophora* and the *Smilotrochus Blanfordi*, so greatly resembling *Smilotrochus incurvus*, D'Achiardi, of the Italian Eocene, an Eocene facies rather predominates.

There are numerous *Caryophylliæ* in the Cretaceous deposits of Southern India, and they were described by Stoliczka in his Monograph of the Cretaceous fauna of Southern India (Memoirs of the Geological Survey of India, 1873); but they are only generically allied to those from the *Cardita-Beaumonti* beds of Sind. They come from strata of Lower Cretaceous age, and there were several genera present which are only known as Tertiary in Europe or recent. In the fauna now under consideration a transition from the Cretaceous to the Eocene is fairly indicated.

VII. *Description of the Fossil Corals from the Ranikot Series of Strata of Sind.*

Nummulitic Series.

List of Species described.

Section **MADREPORARIA.**

Group MADREPORARIA APOROSA.

Family TURBINOLIDÆ.

Subfamily Trochocyathaceæ.

Trochocyathus corbicula, *Duncan.*
Placocyathus striatus, *Duncan.*

Subfamily Turbinoliaceæ.

Blagrovia simplex, *Duncan.*

Family ASTRÆIDÆ.

Subfamily Eusmilinæ.

Trochosmilia Medlicotti, *Duncan.*

Subfamily Stylinaceæ.

Stylina Reussi, *Duncan.*
Stylocœnia maxima, *Duncan.*
Stylocœnia Vicaryi, *Haime.*
———— Ranikoti, *Duncan.*

Subfamily Astræinæ.

Montlivaltia Granti, *Duncan.*
———— Lynyani, *Duncan.*
———— Ranikoti, *Duncan.*
Feddenia typica, *Duncan,* and two varieties.
Feddenia cristata, *Duncan.*
———— elongata, *Duncan.*
Plocophyllia Sindiana, *Duncan.*
———— flabellata, *Reuss.*

Subfamily Lithophylliaceæ meandroideæ.

Diploria flexuosissima, *D'Achiardi.*
Leptoria hydnophoroidea, *Duncan.*

Subfamily Astræaceæ.

Stephanocœnia microtuberculata, *Duncan.*
Astrocœnia Blanfordi, *Duncan,* and variety.
———— cellulata, *Duncan.*
———— nana, *Reuss.*
———— gibbosa, *Duncan.*
Astrocœnia ramosa, *Sowerby.*
Isastræa punctata, *Duncan.*
Astræa Morloti, *Reuss.*
Pironastræa Indica, *Duncan.*
Reussastræa grandis, *Duncan.*

Family FUNGIDÆ.

Subfamily Lophoserinæ.

Pachyseris Murchisoni, *M. Ed. & J. Haime.*
Trochoseris difformis, *Reuss.*
Cyathoseris orientalis, *Duncan.*
Elliptoseris aperta, *Duncan.*
Turbinoseris Ranikoti, *Duncan.*
———— epithecata, *Duncan.*
———— Haimei, *Duncan.*
———— Indica, *Duncan.*
———— elegans, *Duncan.*
Cyclolites alpina, *D'Orbigny.*
Cyclolites Ranikoti, *Duncan.*
———— crenulata, *Duncan.*
———— Vicaryi, *Haime.*
———— anomala, *Duncan.*
———— superba, *Duncan.*
———— Haimei, *Duncan.*
———— Altavillensis, *Defrance.*
———— striata, *Duncan.*
Thamnastræa Balli, *Duncan.*

Group MADREPORARIA PERFORATA.

Family MADREPORIDÆ.

Subfamily EUPSAMMINEÆ.

Stephanophyllia Indica, *Duncan.*

Family PORITIDÆ.

Litharæa grandis, *Duncan.*

Porites superposita, *Duncan.*

Section MADREPORARIA.

Group MADREPORARIA APOROSA.

Family TURBINOLIDÆ.

Subfamily TROCHOCYATHACEÆ.

Genus TROCHOCYATHUS, *M. Ed. & J. H.*

1. TROCHOCYATHUS CORBICULA, *Duncan.* Plate VII, Figs. 12–14.

The corallum is short in height, long and narrow in its very deep and elliptical calice, rounded at the base, generally compressed, and the calicular margins are curved inwardly at the sides.

There is a granular and rather indistinct epitheca; but the costæ are visible at the calicular margin and for some distance down; they are numerous above, subequal, and minutely granular.

The septa are numerous and crowded at the rather broad margin; a few are slightly exsert, and they are very unequal in size and length. They dip down close to the thick wall, and extend very slightly into the calice, and the larger pass along the base of the very deep calicular fossa to the long elliptical and largely developed trabecular columella. The septa are alternately large and small; and the smaller are separated by a longer, which either does not reach far down, or is attached to the columella, by a paliform continuation. There are more than five cycles of septa; the laminæ are thin, often wavy and distinctly granular.

Length of the corallum $\frac{1}{2}$ inch; length of the calice $1\frac{1}{10}$ inch.

Breadth of the calice $\frac{1}{2}$ inch; depth of the calice $\frac{2}{10}$ inch.

Locality. Hills east of Lynyan, Ranikot group. Survey-number G $\frac{280}{126}$.

Illustrations of the Species in Plate VII.

Fig. 12. The corallum from the side: natural size.
13. The base.
14. The calice: slightly magnified.

This species is more closely allied to *Trochocyathus sinuosus* (Brongniart's sp.) of the Eocene of the Vicentin, of Brazzano in the Friuli district, and of La Palarea, than to any other form.

Genus PLACOCYATHUS.

Placocyathus, *M. Ed. & J. H., Hist. Nat. des Corall.* vol. ii. p. 58.

1. Placocyathus striatus, *Duncan.* Plate XIV, Figs. 8–10.

The corallum is simple, short, with a broad attached base and slightly sloping sides, covered with a faint epitheca, through which the straight and alternately large and small, rounded, slightly projecting costæ are seen. The calice is longer than broad, is deep, and the thick margins are slightly sinuous.

The septa are very numerous, small, crowded, and unequal: a few large ones reach the bottom of the fossa, and are in contact with a short lamelliform columella; these septa, probably eighteen in number, have pali at their columellary ends, which merge gradually into the laminæ; the other septa, not reaching so far, are slightly wavy and close to the wall. At the margin there are a number of systems of three septa between two large ones, the middle one of the three being slightly larger than the small one on either side. The costæ are a marked feature, and give a striped appearance to the outside. The sides of the septa are granular; and in some places the granules are nearly worthy of the name of synapticulæ.

Height of the corallum $\frac{3}{10}$ inch.

Length of the calice 1 inch.

Locality. Lynyan, Ranikot group. Survey-number G $\frac{269}{127}$.

Illustrations of the Species in Plate XIV.

Fig. 8. A side view of the coral: natural size.
9. The columella and some pali: magnified.
10. The costæ: magnified.

This is the only representative of the genus in the Indian Tertiaries. The others are of Miocene age in the West Indies.

Subfamily TURBINOLIACEÆ.

BLAGROVIA, *gen. nov.*

The corallum is simple, turbinate or subturbinate, and attached by a small peduncle. The calicular fossa is very deep; the septa are numerous and unequal, and the costæ are covered with an epitheca which permits the larger being seen, and they reach the small base. There are no endothecal dissepiments, pali, or columella.

This genus has close structural resemblances with *Smilotrochus*, from which it differs in the possession of an epitheca and peduncle of attachment.

1. Blagrovia simplex, *Duncan.* Plate XIV, figs. 11–13.

The corallum is small, compressed, turbinate, and the small base has a scar of attachment, and the primary costæ and some secondaries reach it. The septa are very irregular and numerous, and are in sets of three or of five between two larger ones. There are five cycles of them, and a few members of a sixth.

The epitheca is delicate, and forms an integral part of the costal arrangement.

Height of the corallum $\frac{8}{10}$ inch.

Length of the calice $\frac{8}{10}$ inch.

Locality. Three miles west of Lynyan, Ranikot group. Survey number G $\frac{280}{135}$..

Illustrations of the Species in Plate XIV.

Fig. 11. The corallum: natural size.
12. Base and calice: magnified.
13. Septa at the margin: magnified.

Family ASTRÆIDÆ.

Subfamily EUSMILINÆ.

Genus TROCHOSMILIA.

Trochosmilia, *M. Ed. & J. H., op. cit.* vol. ii. p. 181.

1. Trochosmilia Medlicotti, *Duncan.* Plate III, Figs. 2–5.

The corallum is greatly compressed, and is deltoid, wedge-shaped, or flabellate in outline. There is usually a curved pedicel with a mark of former adhesion, but in some the pedicel is straight and sharp. The long, elliptical, rather pointed-ended, and sometimes sinuous calice is usually on a level plane, but sometimes not. It is rather deep centrally, stout at the margin, and crowded with septa.

The costæ are distinct near the calice, and subequal there, slightly projecting, granular, and have small intercostal spaces. Lower down, the costæ become alternately large and small, the smaller being rather linear in some instances. They merge into a pellicular epitheca, or into a "broken" epitheca consisting of irregular-shaped pieces resembling a bad mosaic.

The septa are slightly exsert at the margin, curved above and not dentate. They are crowded, and there are five cycles, with extra orders in large specimens. They are alternately large and small, long and short. The longer gain the axial space and bound it. All are distinctly and largely granular.

There is no columella. The endotheca is scanty. There is a slight exotheca here and there.

The height of the largest specimen is $\frac{7}{10}$ inch, and its calice is in length $1\frac{2}{10}$ inch. The next specimen is $\frac{8}{10}$ inch high, and about an inch in length. A third, drawn on Plate III, is $\frac{4}{10}$ inch high and $\frac{8}{10}$ inch long at the calice.

Locality. Jhirk, Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate III.

Fig. 2. A moderate-sized specimen: natural size, side view.
3. Its calice: magnified.
4. The worn septa: magnified.
5. The granulate septum: side view.

Subfamily STYLINACEÆ.

Genus STYLINA.

Stylina, *M. Ed. & J. H.*, vol. ii. *op. cit.*, p. 232.

1. **Stylina Reussi**, *Duncan.* Plate X, Figs. 11–14.

The corallum is convex above, with gibbous projections, circular in outline, and conical and pedunculate inferiorly.

The upper surface and its gibbosites are crowded with numerous, very slightly projecting, circular, or deformed calices, some of which are separate and others close. The normal calice has a circular, sharp, and rather exsert narrow margin, which is very distinct, a very large, central styliform columella rounded above, and subequal costæ passing over the wall to the intercalicular space, where they terminate.

The septa are alternately large and small, long and short, and there are three cycles in six systems. The primaries and secondaries are much alike, and reach close to and touch the columella; sometimes some do not reach so far. The tertiaries are smaller, and usually do not pass far inwards from the wall. The septa are all smaller than the costæ; and the tertiaries have much larger costæ attached to them than their own laminæ.

In some calices the walls touch, but there is no connexion then by septa-costæ.

The intercalicular space presents the straight ends of the radiating costæ.

The columella, in longitudinal sections, is very large, straight, cylindrical, or slightly compressed, and is marked, from above downwards, with a great number of irregular cross stripes or projecting ridges; these give origin to minute trabeculæ, which join the larger septa to the columella. The sides of the larger septa above, visible in longitudinal section, are minutely granular in lines placed across them.

The endotheca is moderately developed, and the epitheca has been worn off the specimen.

Height of corallum, including gibbous prominence, $1\frac{2}{10}$ inch; breadth $1\frac{8}{10}$ inch.

Diameter of calices $\frac{1}{12}$ to $\frac{1}{10}$ inch.

Locality. Jhirk, Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate X.

Fig. 11. The calices on the corallum: natural size.
12. The calices: magnified.
13. The columella in longitudinal view: magnified.
14. Costæ on base: magnified.

This species is only generically allied to those *Stylinæ* which Reuss described from Castel Gomberto.

Genus STYLOCŒNIA.

Stylocœnia, *M. Ed. & J. H.*, *op. cit.* vol. ii. p. 250.

1. **Stylocœnia maxima**, *Duncan.* Plate XII, Figs. 1–5.

The corallum is large, with a circular and concave base, and has rather thin edges. The upper surface is convex, with a central conico-cylindrical upgrowth. The calices are large, deep, and some of the intercalicular pillars are very stout, long, and usually pointed, whilst others are small and striated.

The calices are largest in the midst and smallest at the edges of the corallum; they are irregularly hexagonal in shape, deep, with a closed fossa as broad as the margin. There is a small styliform columella, which is compressed from side to side, and presents an elongate transverse section. The septa are thin, wide apart, do not project much into the calicular cavity, are often wavy, and ten equal in size unite with the columella. In some calices a very rudimentary intermediate septal series exists, and is continuous on the intercalicular ridge with small costal prolongations.

There are some endothecal growths between the septa, but not extending far from the wall, and the interseptal loculi are closed in below. On the intercalicular ridges, which are moderately broad, are long, linear, short projections, which give off, on either side, costæ which go to the septa, and sometimes two unite to form a septum. On the linear projection is a solitary ridge, and the septo-costal arrangement arises from a reticulation close to the calicular margin. In some instances the linear ridge is broken or sinuous.

The columns or intercalicular pillars are situated at the angle of junction of four or five calices. The largest are broad at the base, and cover nearly as much surface as a calice. The smaller occupy much less space according to their size; they are cylindrical for much of their height, and then are usually compressed but not invariably; they diminish in breadth rather suddenly, and end in a point which is long and blunt. Wide apart, narrow, slightly projecting, sometimes wavy, but usually straight linear projections are placed longitudinally up the columns; they converge at the top, and unite there at a point, or on either side of a short line, and they are sometimes connected throughout their course, here and there, by cross linear projections.

The longitudinal lines sometimes bifurcate, and may be equal or subequal, or an intermediate set may be smaller than the others; and the intermediate structure of the column usually presents a series of more or less regular slight swellings, when slightly magnified.

The longitudinally linear projections of the large columns may be 10, 16, 20, or 24 in number; but the first three numbers are the commonest. They in some instances have a clear relation, at the base of the column, with some of the septa of the neighbouring calices, and with the middle intercalicular linear projections; but in other instances this is not seen, and the columnar "costæ" are independent.

One of the columns on the typical specimen is stunted, and clearly indicates by its construction that it and all of them are aborted gemmations in which the calice has been modified by the unusual growth of the wall and costæ. Another column, broken across, shows that the external longitudinal "costæ" are really such, and are continuous within with irregular septa and endotheca. Moreover the columella may be traced, and it is to be recognized at the top in the line there.

The smaller pillars are miniature larger ones; they cover less space, are usually compressed, and terminate rather bluntly as the remains of an aborted calice, or as a tip with an elongate columella.

The base of the coral, large, symmetrical, resting on its thin circular edge, has concentric rings of epitheca, and a vast number of subequal radiating costæ, whose course is often much broken by the circular layers of epitheca. The costal appearance is produced by a broad rounded and often ornamented epithecate process, which covers each small costa from the outside calices.

The central projection on top of the corallum consists of a mass of calices and columns. The septa of the calices are not arranged in definite cycles.

The breadth of the base is $3\frac{3}{4}$ inches; the height of the corallum to the base of the projection is $1\frac{1}{10}$ inch, and this eminence brings the height to $1\frac{8}{10}$ inch.

The calices are $\frac{1}{10}$ to $\frac{2}{10}$ inch and slightly more in diameter: and the large columns may reach $\frac{1}{2}$ inch in height; their usual height is about $\frac{4}{10}$ inch.

Locality. Jhirk, from the lowest fossiliferous bed, Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate XII.

Fig. 1. The upper part of the corallum: natural size.
2. Part of the base: magnified.
3. A large pillar: magnified, side view.
4. A calice: magnified.
4a. Side view of a section.
5. The top of a column: magnified.

This remarkable coral is common, and always assumes the same shape. It is allied to ***Stylocœnia macrostyla***, Reuss, from the strata near S. Giov. Ilarione, in the Bolca and Montebello district of the Alps, and which is found with ***Cerithium giganteum*** and ***Nummulites planulatus.*** The especial point of interest in the species is the gigantic development of the small projections seen in some of the ordinary European Eocene *Stylocœniæ.*

STYLOCŒNIA MAXIMA, *Duncan.* Plate XII, Fig. 6.

A young specimen, with the same kind of base, calicular marginal lines, and septa as the type, has only the usual upward enlargement of the calicular meeting-points. Indications of a commencing central projection exist. It may be mistaken for ***Stylocœnia emarciata***, Lamk. sp., of the European Eocene deposits.

Illustration in Plate XII.

Fig. 6. The corallum: natural size.

2. STYLOCŒNIA VICARYI, *Haime.* Plate XIII, Figs. 4–7.

This Stylocœnian was described by D'Archiac & Haime in their great work, 'Les Animaux Fossiles du groupe Nummulitique de l'Inde,' and was figured by them (plate xii, fig. 4, 4 *b*, p. 189). They notice the similarity of the species with those from La Palarea in the European Nummulitic strata, and classify the form amongst the ***Stylocœniæ*** with three cycles of septa, noticing that the primaries alone reach the columella, which is rather large and cylindrical, that the secondaries do not reach the columella, and that the tertiaries are rudimentary. They give the diameter of the calice as $1\frac{1}{2}$ millim. They describe the corallum as thick and semiglobular; and Haime and Milne Edwards state it to be hemispherical.

There is a fine specimen of a Stylocœnian from Jhirk, in the Ranikot group, which approaches the above description too closely to permit of its association with any other species than *Stylocœnia Vicaryi*. It is a large form, well developed, and is thick but not hemispherical, for it is rather convex in one direction and long and flat in the other. The intercalicular projections are small and mere elevations at the angles. The calices are over 2 millimetres in breadth, and the columella is well developed and cylindrical. The primary and secondary septa are equal and reach the columella, all being slender, and not being much thicker at the margin, if at all, than at the columella; and the tertiaries reach midway towards the centre of the calice.

This increased size of the septa is a mere matter of growth. The endotheca is scanty.

Locality. Jhirk, Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate XIII.

Fig. 4. Part of the corallum: natural size.
5. A worn calice: magnified.
6. Calices: magnified.
7. Diagram of the margin of the calices.

3. Stylocœnia Ranikoti, *Duncan.* Plate XV, Figs. 6–9.

The corallum is large, the basal edge is circular, and the upper surface of the corallum is symmetrical, rising gradually to a blunt point, and being covered with large calices.

The base has an epitheca. The calices are more or less hexagonal, two sides being smallest, or round or angular, and they are rather deep, and are separated by narrow, sharp margins. The columella is exceedingly small in relation to the size of the calices, and aborts occasionally, being replaced by an elongate mass; it is situated deeply and compressed. The septa are ten in number, distant, small, some often uniting before they reach the columella; they are subequal, and form but little of the calice. The columns between the calices are small.

Breadth of corallum at base $2\frac{5}{10}$ inches; height $1\frac{1}{10}$ inch.

Diameter of calices usually $\frac{2}{10}$ inch and more.

Locality. Hills east of Lynyan, Ranikot group (Survey-number G $\frac{280}{127}$), and Vihan Hill (Survey-number G $\frac{226}{157}$).

Illustrations of the Species in Plate XV.

Fig. 6. The corallum: magnified.
7. Calices: magnified slightly.
8. Calices: more highly magnified.
9. A side view of a septum: magnified.

Subfamily ASTRÆINÆ.

Genus MONTLIVALTIA.

Montlivaltia, *M. Ed. & J. Haime, op. cit.* vol. ii. p. 296.

1 Montlivaltia Granti, *D'Archiac & Haime.* Plate XI, Figs. 14–17.

The corallum is hemispherical when full-grown, flatter and convex without and concave within when young. The calice, widely open and shallow, is slightly elliptical, and the axial space is of the same shape. The septa are slightly exsert at the margin, rounded, slightly granular, and usually long, straight, and often rise on the free margin into several minute lobes, of which there is a crown around the axial space. There are at least six cycles of septa which are close at the wall. The larger septa are subequal, and there is a considerable number of them, but they are small in relation to the size of the calice; they are subequal at the costal end, and largely granular there. There is no columella.

The epitheca is granular, and is in strong transverse folds, the costæ showing between them, and it reaches very close to the margin.

The base is very slightly flattened in old forms, as if by pressure; but it is rounded in the young, in which the costæ do not show through the perfect epitheca.

In the young forms the calice is deeper and there are fewer septa, but still they are numerous.

The costæ in the fully-developed forms are subequal, project but slightly, are close, and have much exotheca between them. They are in little groups of longitudinal convex fluting in the old forms, and each group consists of two large costæ and three intermediate ones between them.

Height of corallum: large, $1\frac{6}{10}$ inch; small, $\frac{8}{10}$ inch.

Length of calice: large, $2\frac{6}{10}$ inches; small, $1\frac{9}{10}$ inch.

Locality. Hills east of Lynyan, Ranikot group. Survey-number G $\frac{289}{134}$..

Illustrations of the Species in Plate XI.

Fig. 14. Large corallum: natural size.
15. The septa (part of): magnified slightly.
16. The costæ and epitheca: magnified.
17. Small corallum: natural size.

This species was described and delineated by MM. D'Archiac and Jules Haime in their work, which has already been quoted; and the specimens from Lynyan agree in their structures with the specific distinctions given. The type figured by them is a more feebly grown individual than the larger form described above. In the lobed character of the septal ends there is much similarity to the genus *Antillia*, Duncan; but there does not appear to be a columella, which structure peculiarizes this genus.

2. **Montlivaltia Lynyani**, *Duncan*. Plate XVI, Figs. 1, 2.

The corallum is very large, cylindro-turbinate, rounded and turbinate below at the base, and cylindrical, with salient angles, above.

The calice is irregular in outline, widely open, and not deep. The margin is thin, and there is a raised ridge of paliform septal lobes around the axial space. The septa are close, not very stout, and there are nearly six cycles of them. The costæ are subequal, or alternately large and small, sharply granular at the free edge, and rather distant. The epitheca is well developed as a layer, which is granular on its surface, and as bands between which the costæ are visible. The endotheca and exotheca are abundant.

The height of the coral is 3 inches. The breadth of the calice is rather over 2 inches.

Locality. Three miles west of Lynyan, in the Ranikot group. Survey-number G $\frac{289}{138}$.

Illustrations of the Species in Plate XVI.

Fig. 1. The corallum, side view.
2. Some of the costæ and epitheca: magnified.

The paliform endings of the septa, so remarkable in the last species, occur in this one.

3. **Montlivaltia Ranikoti**, *Duncan*. Plate III, Figs. 12–14.

The corallum is short, irregularly elliptical, large and widely open above, and almost hemispherical and slightly pointed beneath. The height is about equal to one half of the width of the smaller diameter of the calice.

The calicular margin is broad; the axial space is elliptical, small, restricted, and deep, and the space between it and the margin is moderately deep. There are 76 septa, and the fifth cycle is incomplete in some systems. The septa are stoutest at the margin, where they are slightly exsert; they are thin, slightly and largely granular at the sides, slightly arched and faintly notched at their free margin, long, distinct, and not crowded. They reach or extend towards the axial space according to their orders; the primaries reach it, and the secondaries also in some instances; the secondaries and tertiaries are a little remote from it, and those of the higher orders are still more so. There is frequently an approach, near the axial space, of two smaller septa towards the larger one between them, and they come in greater or less contact. The axial space is deep, and is bounded by the curved inner septal edges, and there is no columella. The costæ correspond to the septa, are alternately large and small, and are distinctly yet feebly developed; they project with greater distinctness at some part than at others.

The endotheca is very scanty.

An epitheca, without ornamentation and more or less pellicular, exists, closely covering the costæ and intercostal spaces, but the irregular projections of the costæ mark it. The base is small, semipedunculate, and free.

Height of the corallum $\frac{8}{10}$ inch.

Breadth of calice about $\frac{7}{10}$ inch.

Locality. Jhirk, from lowest fossiliferous beds of the Ranikot group. Survey number G $\frac{280}{124}$.

Illustrations of the Species in Plate III.

Fig. 12. The coral: natural size.
13. The calice: magnified.
14. The costæ: magnified.

Genus FEDDENIA, *Duncan.*

The corallum is simple, free, with an irregular-shaped base, which has enclosed a foreign body. The epitheca is granular, and occasionally like broken mosaic. The costæ may or may not be universally visible, and are continued to the base, but not invariably to the peduncle. The calice, usually constricted, is crowded with uniting septa, ending in paliform lobes; it is without columella. The endotheca is scanty, but the granules of the septa unite here and there as false synapticulæ.

1. Feddenia typica, *Duncan.* Plate XI, Figs. 1–3.

The corallum is free, compressed, and Phrygian-cap-shaped, and the projecting part of the base is marked with the openings for the shell it surrounded. The calice is oval, deep, with a faintly irregular margin and a small elongate axial space, which is bounded by the paliform ends of the largest septal groups, which are ten in number. There is no columella. At the margin, the costal edge is festooned, two projecting costæ ending in a large septum, and having seven between them. The projecting costo-septa have, on either side, a minute septum of a high order, which is taller than the others. There are five cycles of septa; and the larger laminæ are thick, often much curved, and have protecting granules and ridges. The next in size project less, and are also curved; whilst the smallest septa are largely granular, and unite by their granules with the others, besides uniting laterally with a larger septum. The paliform ends are wavy, broken-looking, and broad.

The costæ are subequal and exist near the calice, the larger, with the two lateral costæ, forming prominences for some little distance straight down the outside. Elsewhere they are covered with the epitheca.

Height of corallum $\frac{7}{10}$ inch.
Length of calice $\frac{8}{10}$ inch.
Locality. Three miles west of Lynyan, Ranikot series. Survey-number G $\frac{280}{123}$.

Illustrations of the Species in Plate XI.

Fig. 1. Side view of the corallum: natural size.
2. The calice (part of): magnified.
3. The costæ and epitheca: magnified.

Feddenia typica, *Duncan.* Variety 1. Plate XI, Figs. 4, 5.

In this variety the same general shape of the corallum exists. The septa are larger and very largely granular. The costæ are large near the calice, which is elliptical and contracted. The false synapticulæ are large. The epitheca is granular. From the same locality as the type.

Illustrations of var. 1 *in* Plate XI.

Fig. 4. The septa: magnified.
5. The granules on a septum: magnified.

Feddenia typica, *Duncan.* Variety 2. Plate XI, Figs. 6, 7.

This variety is from the same locality as the type. The corallum is taller, and still retains the general shape. The costæ are very granular, and the granules merge into those of the epitheca near the calice. Elsewhere the epitheca is minutely granular. The higher orders of septa are not so decidedly higher than the others on the side of the larger septa. The costæ are very wavy on the side where they coalesce.

Illustrations of var. 2 *in* Plate XI.

Fig. 6. The corallum: natural size.
7. Costæ and septa: magnified.

2. **Feddenia cristata**, *Duncan.* Plate XI, Fig. 8.

The corallum is free, tall, very compressed, with a small rounded base, which curves up to a keel-like crest that reaches the calice at one of the ends of the elliptical margin; a corresponding but smaller keel exists at the opposite end, and passes straight down to the base, which is gently curved sideways.

The calice is contracted, shallow, elliptical, and crowded with septa, the larger reaching into the small axial space. There are four cycles of septa, which are not very granular, and which have the generic distribution. The costæ project in sets, which become more prominent near the curved end of the corallum at the calice, until the terminal form a decided ridge or keel. Lower down, the costæ become covered with the broken-looking epitheca; but they are still visible and subequal. Some pass straight down from the calice, and others, after a space, take on an oblique course, which gives a regularly wavy appearance to the sides of the corallum. The base has enclosed an organism, and the costæ have followed the growth of the enclosing structure rather than that of the narrow peduncle-like end.

Height of corallum $2\frac{2}{10}$ inch.

Breadth of calice $\frac{7}{10}$ inch; length of calice $1\frac{1}{10}$ inch.

Locality. East of Kandaira, Ranikot group. Survey-number G $\frac{226}{155}$.

Illustration of the Species in Plate XI.

Fig. 8. Side view of the corallum: natural size.

3. **Feddenia elongata**, *Duncan.* Plate IV, Figs. 8–10.

The corallum is tall, rather compressed, and the base is curved and flattened beneath. The costæ, distinct near the calice, either merge into a broken mosaic-like epitheca or pass straight downwards with gentle undulations, so as to reach the lower end, but not the curved base. The costæ are in sets at the margin, three small being between two large; they are well developed, slightly projecting, granular, united by exotheca, and the largest order is not invariably taller than the others. The calice is elliptical, contracted, shallow, and the septa corresponding with the larger costæ pass in towards the small axis. The transverse section below the calice indicates that the septa are not very granular, that they have few false sympliculæ, and that there is a false columella, produced by trabeculæ from the septal ends. There are five cycles of septa, a few orders of the sixth.

Height of corallum 2 inches.

Length of calice $1\frac{2}{10}$ inch; breadth of calice $\frac{7}{10}$ inch.

Locality. Three miles west of Lynyan, Ranikot group. Survey-number G $\frac{280}{128}$.

Illustrations of the Species in Plate IV.

Fig. 8. Side view of the coral.
9. The costæ: magnified.
10. A transverse section of the coral: magnified.

Genus PLOCOPHYLLIA, *Reuss.*

1. PLOCOPHYLLIA SINDIANA, *Duncan.* Plate XIII, Figs. 1–3.

This species is founded on a small massive corallum, with a few extremely large corallites, separate above, short, and presenting some Heliastræan peculiarities. There are no Nummulites about the specimen; and I have doubts, from its mineralization, whether it really came from Jhirk: it looks more recent than the others from that spot.

The corallum is broad above, small below, short, and massive. All the calices are large, deep centrally, but shallow and expanded at the margins, which are oval or irregular in outline. The costæ are distinct above, project slightly, are unequal, and those of one calice do not pass over to others. Possibly there are 144 or more subequal septa in the calices; they are thin, crowded, faintly dentate at the free edge, and a considerable number reach the large papillose columella, which is situated deeply. There does not appear to have been any epitheca.

The diameter of a calice is $1\frac{8}{10}$ inch. Depth of fossula $\frac{4}{10}$ inch.

Locality. Jhirk (?), Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate XIII.

Fig. 1. The corallum: natural size.
2. The costæ: magnified.
3. A septal edge: magnified.

This species has the appearance of a short *Plocophyllia*, of the *Plocophyllia-gregaria*, Reuss, type from S. Giov. Ilarione.

2. **Plocophyllia flabellata**, *Reuss.* Plate XVI, Figs. 5, 6.

A little stem of this coral, with a compressed calice and visible costæ, slightly compressed sides, and a scar of former adhesion, was found in the hills east of Lynyan. It resembles a young *Plocophyllia* of the group *flabellata*; and I refer the specimen to that species, which my late friend the illustrious A. E. Reuss described from Monte di Carlotta, in the San Giovanni Ilarione district ('Pal. Stud. über die älteren Tertiärschichten der Alpen,' iii. Abtheil. p. 30).

Locality. Hills east of Lynyan, in the Ranikot group. Survey-number G $\frac{280}{128}$.

Illustrations of the Species in Plate XVI.

Fig. 5. Side view of the corallum: natural size.
6. The costæ: magnified.

Subfamily LITHOPHYLLIACEÆ MEANDROIDEÆ.

Genus DIPLORIA.

Diploria, *M. Ed. & H. op. cit.* vol. ii. p. 401.

1. **Diploria flexuosissima**, *D'Ach.* Plate VI, Figs. 11, 12.

Diploria flexuosissima, *D'Ach. Corall. foss. del terr. numm. delle Alpi venete*, ii. p. 26, tab. xii. fig. 4; *Reuss, Anthoz. von S. Giovanni Ilarione*, p. 11, pl. xxxix. figs. 1, 2.

The corallum is irregular in shape, generally flat and cake-shaped, and is rather gibbous on the upper surface. The series are very gyrose, and the interserial portion is about as broad as the serial, and is on rather a lower level. The series are narrow, and the septa are numerous, alternately large and small, the larger having a swelling parallel with the axial space, sometimes rising in a small lobe. There are about 40 septa in half an inch. The small septa may be rudimentary, and are then continued outwards as minute costæ, and the larger, which are stout, end in the principal costæ.

The columella is continuous, thin, and distinct. The endotheca is very well developed and close.

The length of the corallum is about $\frac{1}{2}$ inch; the breadth of a series and one interseries is $\frac{2}{10}$ inch.

Locality. Jhirk, Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate VI.

Fig. 11. Upper surface of the corallum.
12. A portion of a calicular series: magnified.

Genus LEPTORIA.

Leptoria, *M. Ed. & J. H. op. cit.* vol. ii. p. 405.

1. **Leptoria hydnophoroidea**, *Duncan.* Plate VIII, Figs. 1, 2.

The corallum is hemispherical, and is placed on a large elliptical base, with rounded-off edges and a slightly concave central part, marked with concentric ridges. The upper surface of the corallum slopes for a short distance from the base, and is then broken up into many series, some of which are long and others very short, some being straight and others curved. The calices are perfectly indistinct, and the costæ of the collines and monticules are alternately large and small, slightly projecting, and in number about ten large ones and as many small in half an inch. They pass upwards from considerable depths, and form, with those of the neighbouring series, thick nodular, and long and short, broad and narrow collines, with a rather sharp or a nodular summit. The valleys are very deep, reaching down from $\frac{4}{10}$ inch to 1 inch; and the septa are granular at the edge, project but slightly, have some endotheca between them, come close together along the floor of the series, and have a projection there. There is a distinct thin lamellate columella, which is very continnous. The costæ of the base cover its upper sloping portion, and are seen around the edge; they are small, subequal, slightly prominent, and have exotheca regularly placed concentrically between them. There are traces of an epitheca.

Height of the corallum $2\frac{8}{10}$ inches. Length of base $3\frac{8}{10}$ inches.

Breadth of base $3\frac{2}{10}$ inches. Length of longest colline $1\frac{1}{2}$ inch; of the shortest $\frac{2}{10}$ inch.

Locality. Hills east of Lynyan, Ranikot group. Survey-number G $\frac{289}{127}$.

Illustrations of the Species in Plate VIII.

Fig. 1. The corallum: natural size.

2. A series: magnified.

Subfamily ASTRÆACEÆ.

Genus STEPHANOCŒNIA, *M. Ed. & J. H., amended.*

(Shown to have incised and ragged septal edgings.)

1. STEPHANOCŒNIA MICROTUBERCULATA, *Duncan.* Plate XV, Figs. 14–16.

The corallum is large, rather flat, slightly irregular on its calicular surface, and incrusts.

The calices are irregular in shape, although regular in size, and are in hexagons, pentagons, or are indefinitely square and circular; they are shallow, open, and are separated by stout, equal margins, which are minntely granular and marked with enlarged septo-costal swellings. The septa are delicate, rather large near the wall, then thin, and finally expand near the axial space to unite and form a kind of paliform collar around the extremely small, tubercular-looking, essential columella. There are twelve larger septa, which reach the axis, or one or two may occasionally join others before doing so. Twelve smaller septa, often very small, intervene; and thns there are three cycles, the primaries and secondaries being nearly or quite eqnal. The axial part occupies much of the fossa of the calice, and in worn specimens especially. The minute columella aborts frequently, or is lost in fossilization, being rarely perfectly preserved. Sometimes there is the trace of a groove between the calices.

Height of corallum $\frac{5}{10}$ inch; length many inches. Length of calices rather under $\frac{1}{10}$ inch.

Locality. Jhirk, Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate XV.

Fig. 14. A part of the corallum.
15. Calices: magnified.
16. A calice with an aborted columella: magnified.

Genus ASTROCŒNIA, *M. Ed. & J. H., amended.*

1. ASTROCŒNIA BLANFORDI, *Duncan.* Plate XV, Figs. 1–5.

There are some very remarkable corals in the Ranikot group of the Sind Tertiaries belonging to the genus *Astrocœnia,* which are circular at their concave and epithecate base, and which are produced upwards in the shape of a stump or stalk; others have a convex upper surface, and some are intermediate. The calices in all are large, and the septal number is ten, any addition being rare and, in fact, doubtful. The growth of the corals is at the circular edge of the corallum; but every now and then a bud is formed on the united margins of three or four calices. In some there is a disposition to show the Stylocœnian peculiarity; but it is a matter of normal growth, and not of the development of aborted buds with costæ on them. The stalk is the remains of the young coral, which has grown more in height than in basal breadth.

The type of this little group of the genus is *Astrocœnia Blanfordi,* and the following is the description:—

The corallum is large, circular at the base-edge, where it is thin and crowded with small calices; the upper surface of the corallum slants upwards and inwards without greatly increasing the thickness until the "stalk" is reached, and this is cylindro-conical and slightly bent. All the upper surface and the stalk are covered with subequal hexagonal, rounded, and irregular-shaped calices. The base is concave, and has a dense epitheca showing circular folds, ridges, and depressions, the costæ being barely visible.

The calices, when hexagonal, have four sides larger than the other two, and are not deep. The intercalicular space is narrow, and has on it a wavy ridge, on which the septa of neighbouring calices sometimes unite.

The columella is small, free above, styloid, and sometimes elongate in the direction of the long axis of the calices, but usually it is nearly circular in outline.

The septa are ten in number, nearly equal, small, slightly toothed, narrow, and wide apart; they are not exsert, but dip down at once into the calice, not filling it much; and two often unite before reaching the columella. All the others reach the columella, which in some calices has a kind of swelling or collar, just above the septal junction. In one specimen there is a single large calice, in the midst of others of the usual kind, which has twenty septa; but it appears that ten of them reach the columella fairly, the rest joining others close to it. Nevertheless the presence of rudimentary septa between the usual ten, in ordinary calices, is not noticed.

The width of the base is $2\frac{8}{10}$ inches; the height of the corallum is $1\frac{1}{2}$ inch, and that of the corallum from the margin to the base of the stalk is $\frac{6}{10}$ inch.

The calices differ in size, but seven of them are included in 1 inch of length. The solitary large calices are $\frac{2}{10}$ inch long and very shallow.

Locality. Three miles west of Lynyan, Ranikot group. Survey-number G $\frac{280}{128}$. .

Illustrations of the Species in Plate XV.

Fig. 1. The corallum: natural size, side view.
2. The corallum from above.
3. The base, part of: slightly magnified.
4. Calices: magnified.
5. Side view of a dentate septum: magnified.

ASTROCŒNIA BLANFORDI, *Duncan.* Variety.

This variety has only a short stump instead of a stalk; and the calices, hexagonal as a rule, are elongate radially, and the short sides are therefore internal and external.

It is from the same locality as the type.

2. ASTROCŒNIA CELLULATA, *Duncan.* Plate XIV, Fig. 7.

The corallum is circular in outline, and is short, being very slightly convex above, and furnished with a complete epitheca with concentric folds below. No costæ are visible.

The calicular surface is crowded with small calices, which are shallow and pentagonal, hexagonal, or deformed in outline. A raised margin separates the calices, whose septa arise from it, and there is a ledge of endotheca, resembling an inner margin, one third or midway between the calicular marginal edge and the columella. There are usually ten distant, thin septa, which pass from the margin over the ledge to the small, rather compressed, styloid columella. In a few calices a rudimentary septum exists, here and there, between the others.

Length of corallum not quite an inch; height, extreme, $\frac{2}{10}$ inch. Breadth of calices $\frac{1}{15}$ to $\frac{1}{12}$ inch.

Locality. Jhirk, in the Ranikot group. Survey-number G $\frac{280}{124}$.

Illustration of the Species in Plate XIV.
Fig. 7. Calices: magnified.

3. ASTROCŒNIA NANA, *Reuss.* Plate XV, Figs. 10, 11.

A specimen of a small-caliced Astrocœnian, smaller than the type from Monte delle Carrioli described by my lamented friend A. E. Reuss (in his 'Paläontologische Studien über die älteren Tertiärschichten der Alpen,' pt. 1, 1868, p. 40, Vienna), is a considerable block of massive coral covering many inches of surface and some of height.

The calicular surface is plane or slightly undulating, and the calices are close together, small ($\frac{1}{20}$ inch), and the columella is distinct, rather large, and is met by eight equal septa. These have a paliform enlargement a little remote from the columella; and there are eight minute spinose-looking intermediate septa.

Locality. Jhirk, Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate XV.
Fig. 10. A piece of the corallum.
11. Calices: magnified.

4. Astrocœnia gibbosa, *Duncan.* Plate XII, Figs. 7–10.

The corallum is massive, concave beneath, where it covered shells and other foreign substances, and gibbous and rising centrally in a nodular form above; it is thick, and the crowded corallites are tall.

The calices are circular and rarely polygonal, are separated by granular cœnenchyma, or by a ridge, or they may be close and without any intermediate cœnenchyma, according to the growth. A subreticulate appearance is sometimes produced by the prolongation of the short costæ reaching the intercalicular ridge.

There are eight septa, which are subequal, with a convex and arched outline where free above; they are stout near the margin and smaller at the columella. No other septa are seen, except in very rare instances, and their existence is exceptional. A costa frequently exists between those of the septa.

The columella is stout, styliform, prominent and rounded above, and it is furnished, as it were, with a collar at the place where the septa join it.

Very small calices have the eight septa.

The endotheca is largely developed and is close.

Breadth of the corallum 3 inches and more; height 2 inches.

Where the intercalicular tissue is well developed there are about five calices and their intermediate tissue in ½ an inch of length; but when the calices are close there are about eight in the same space.

Locality. Jhirk, in the Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate XII.
Fig. 7. The corallum.
8 & 9. Calices with intermediate tissue: magnified.
10. Side view of a septum: magnified.

5. Astrocœnia ramosa, *Sowerby*, variety minor. Plate XII, Figs. 11, 12.

Some portions of small broken branchlets, with the usual tuberose outlines of the West-Indian varieties of the type, are found in the Ranikot group of strata south-west of Jhirk.

The specimens vary from the type in having smaller calices, the calicular margin of one calice being separated by a furrow from its neighbour and preserving a circular outline, and the branches are very small. As is common in the type, there are eight primary septa which reach the columella, even in corallites just budded, and eight small ones. The costæ on the flat wall are nearly equal. The columella is large.

The calices are usually $\frac{1}{20}$ inch broad.

This species has varieties in the Eocene of St. Bartholomew in the West Indies (P. M. Duncan, Quart. Journ. Geol. Soc. 1873, vol. xxix. p. 554); and the type is a Cretaceous form from Gosau.

The *Astrocœnia nana* of Reuss, from the Eocene in the older Alpine Tertiaries, is the nearest ally to the form; but it has no intermediate area between its calices, and it is massive and not ramose.

Locality. South-west of Jhirk, Ranikot group. Survey-number G $\frac{226}{165}$.

Illustrations of the Variety in Plate XII.

Fig. 11. The corallum.
12. Calices: magnified.

Genus ISASTRÆA.

Isastræa, *M. Ed. & J. H. op. cit.* vol. ii. p. 526.

1. Isastræa punctata, *Duncan*. Plate XVIII, Figs. 10–13.

The corallum is very short, and has an epithecate concave base, circular in outline, and marked with growth-rings. The calicular surface is slightly convex; the calices are small, crowded, hexagonal, and shallow. There are twenty-four septa, which are subequal, and their worn spines give a punctate appearance to them.

Height of corallum $\frac{1}{25}$ inch; breadth $\frac{5}{10}$ inch. The calices are about two in $\frac{1}{10}$ inch.

Locality. Ranikot group, hilly ground N.E. by E. of Petiáni. Survey-number G $\frac{260}{135}$.

Illustrations of the Species in Plate XVIII.

Fig. 10. The corallum from above: natural size.
11. The base: natural size.
12. Calices: magnified.
13. Side view of the corallum.

Genus ASTRÆA.

Astræa, *M. Ed. & J. H. op. cit.* vol. ii. p. 506 (*Siderastræa*, Blainv.).

1. Astræa Morloti, *Reuss* (small variety). Plates VII, Figs. 15, 16.

Reuss described a massive *Astræa* from Oberburg, in Steiermark, in one of his celebrated essays on the Upper Eocene Coral-faunas of continental Europe; and a form from the Ranikot group must be associated with it, as a variety with smaller calices and from 24–30 septa. (Reuss, "Die fossilen Foraminiferen, Anthozoen, &c. von Oberburg," Denkschriften der kaiserlichen Akad. der Wissenschaften in Wien, 1864, p. 23: *Astræa Morloti*, plate 6. fig. 1.)

In the Sindian specimen the upper surface of the corallum is flat and covered with calices about $\frac{1}{10}$ inch broad. The septa are crowded; many reach the papillary costæ or have a palus before them; some, in rare instances, enter neighbouring calices. The fossa is shallow, and the calicular margins are rather flat.

Locality. Three miles south-west of Jhirk, Ranikot series. Survey-number G $\frac{280}{125}$.

Illustrations of the Species in Plate VII.

Fig. 15. The corallum: natural size.
16. Some calices: magnified.

Genus PIRONASTRÆA.

Pironastræa, *D'Achiardi, Coralli eocen. di Friuli* (*Pisa*, 1875).

1. Pironastræa Indica, *Duncan.* Plate VII, Figs. 17–19.

The corallum is thin, flat, discoid, and the calices are in concentric series, each series being represented by a slight swelling or outline which usually is marked by costæ. The calices are distinct as a rule, but sometimes are slightly confused; they are small, and the septo-costæ join frequently before reaching the empty axial space. The costæ are subequal, bifurcate, and trifurcate, or are straight for some little distance. The septa are also subequal and small. Eight or nine septa reach the axial space, and twenty-four or more costo-septa enter into the calicular system. There is no columella. The base is ringed with depressions and elevations, and is marked with very fine circular costal striæ. The epitheca exists, and synapticulæ are numerous between the costæ inferiorly.

Breadth of corallum (originally) $2\frac{6}{10}$ inches; thickness $\frac{1}{10}$ to $\frac{3}{10}$ inch.

Locality. South-west of Jhirk, Ranikot group. Survey-number G $\frac{226}{165}$.

Illustrations of the Species in Plate VII.

Fig. 17. The corallum.
18. Calices: magnified.
19. The base of the corallum: nat. size. Outline restored.

The genus is represented by a discoid form, closely allied to *Pironastræa Indica*, in the middle series of the Eocene of Friuli, where other Sindian species have been discovered by D'Achiardi.

Genus REUSSASTRÆA, *D'Achiardi.*

Prof. Antonio D'Achiardi founded the genus *Reussastræa* in memory of the late illustrious zoophytologist, A. E. Reuss. It includes *Thamnastræidæ* with a lamellar columella. ('Coralli eocenici del Friuli,' Pisa, 1875, p. 67.)

1. Reussastræa grandis, *Duncan.* Plate X, Figs. 1–4.

The corallum is very large, thin, very short, rather irregular on the surface, sharp at the edges, and covered with calices and costæ above, and presenting costæ on the base, with slight evidence of epitheca.

The calices are circumscribed, unequal in size, various in shape, and very irregular in their distance. The septa are few in number, alternately large and much smaller; or they are in sets of fours, one septum being the largest, and the central of the three others is larger than those at its sides. The septa unite much close to the columellary space, and some are thick there. The columella is formed by the union of the septa, and where perfectly preserved is short and lamellar; but the lamina forming its top is rarely preserved. The septa reaching the axial space may be 12, 16, 18, 21, and rarely more in number. The costæ are alternately large and much smaller, and are separated by distinct and deep spaces with exotheca; they are often very long, are usually wavy in their course, and in some places curve much and enclose a larger or smaller one. They are granular at the sides and edges, in well-preserved parts.

The base of the coral is thin externally and stout where it probably rested; and the costæ are long, straight, and unequal. Probably this genus will be included in the Fungidæ.

The length of the calices is about $\frac{3}{10}$ inch.

Locality. South-west of Jhirk, Ranikot group. Survey-number G $\frac{229}{163}$.

Illustrations of the Species in Plate X.

Fig. 1. A calice: magnified.
2. Calices: magnified.
3. Costæ from the upper surface: magnified.
4. Costæ on the base: magnified.

Family FUNGIDÆ.

Subfamily LOPHOSERINÆ, M. Ed. & Haime, op. cit. vol. iii. p. 35.

Genus PACHYSERIS.

Pachyseris, *M. Ed. & Haime, op. cit.* vol. iii. p. 85.

1. Pachyseris Murchisoni, *D'Archiac & Haime.* Plate XIV, Figs. 3, 4.

The generic and specific characters of this coral, given in the work on 'Les Animaux Fossiles de l'Inde,' are seen in some specimens, which unfortunately are rather worn and over-weathered. In addition, it is shown from their consideration that the corallum is large, massive, flat, and not very thick. The series are numerous, not much gyrose, but bifurcating and short. Some calices are limited. The collines are flat at the top and granular; the side slopes with the opposite one of the same colline, forming a large angle. The series are not deep; there is a false columella; and the septa, alternately large and small, are visible, not very crowded, and about 16 to 20 are found in rather less than half an inch. The synapticulæ are few and well marked.

The corallum is many inches long and about an inch in height.

Locality. Jhirk, Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate XIV.

Fig. 3. The upper surface of the corallum.
4. A series: magnified.

Genus TROCHOSERIS.

Trochoseris, *M. Ed. & Haime, op. cit.* vol. iii. p. 57.

1. **Trochoseris difformis**, *Reuss*. Plate XI, Figs. 9, 10.

The corallum is irregularly conical, and expanded at the calicular margin, which is more or less lobed and stout. The corallum is free, and is covered with a dense epitheca, through which few costæ are seen.

The calice, irregular in shape, is elliptical on the whole, shallow, expanded, and with a long and deep axial space. The columella is rudimentary. The septa are exceedingly numerous and very unequal; the smaller series are very frequent, and additional septa of a higher order reach down by the sides of the three, which finally join and are ended by a palus. The septa are nearly or quite 400 in number. The synapticulæ are very numerous, and there are bands of endotheca stretching from one series of septa to others. The septa are slightly granular.

Height of corallum $1\frac{1}{10}$ inch.

Length of calice $1\frac{9}{10}$ inch.

Locality. Jhirk, Ranikot group. Survey-number G $\frac{280}{124}$.

This species was described by Reuss from Zovencedo and Monte Grumi in the Castel-Gomberto district; and the Sind form resembles it, except in the depth of its calice (Reuss, "Paläont. Studien über die ält. Tertiärschichten der Alpen," Denkschr. der kaiserlichen Akad. der Wissenschaften in Wien, Abth. i. pp. 6, 50, iii. p. 25).

Illustrations of the Species in Plate XI.

Fig. 9. Corallum: natural size.
10. Septa: magnified.

Genus CYATHOSERIS.

Cyathoseris, *M. Ed. & H. op. cit.* vol. iii. p. 59.

1. **Cyathoseris orientalis**, *Duncan*. Plate VI, Figs. 7–10.

The corallum is large and short, and expands suddenly from a short, irregular pedicel; and the upper surface is slightly convex, more or less circular in outline, and has lobed edges, which are thin.

The calices, indistinct in their limits, are large, widely open, shallow, and are united laterally by a linear common wall, over which the septa unite; they form rounded lobes at the edge of the corallum. The septa are numerous, and are alternately large and very small; some are long, and others slightly shorter and prominent, and all rather depressed. They frequently curve laterally, and the larger have a paliform lobe; and although all are thin, the larger become stouter near the axial space. In a rounded calicular edge, $\frac{8}{10}$ inch across, there are 48 septa. The septa are profusely granular, and here and there the granules develop into synapticulæ, which are best seen in longitudinal sections.

The columella is small and trabecular. The underpart of the corallum is striated with costal markings on a rather undulating surface; they are subequal, small, regular, and usually alternately large and a little smaller, especially near the margin; but nearer the pedicel the striæ are nearly equal.

Height of corallum $1\frac{3}{4}$ inch; breadth of upper surface $4\frac{1}{2}$ inches.

Breadth of the largest calice $1\frac{1}{10}$ inch.

Locality. Jhirk, Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate VI.

Fig. 7. Side view of the corallum: natural size.
8. Septa, magnified, showing synapticulæ.
9. Junction of septa on a colline.
10. Costal striæ of underpart: magnified.

ELLIPTOSERIS, gen. nov.

The corallum is simple, conical, compressed, with a largely open, elliptical calice. There are costæ, but no epitheca; there is no columella, but an elongate and deep axial space. The septa are numerous, and the smaller join those between them near the axial space. There are pali before the joined septa. Synapticulæ are numerous in the calice.

1. Elliptoseris aperta, *Duncan*. Plate VIII, Figs. 3–6.

The narrow peduncle presents traces of rupture from a former attachment. The costæ pass up the conical and rapidly expanding body to the calicular margin, and are small, close, granular, and subequal.

The calice is very widely open, and is slightly convex from the axial space to the margins. The septa are very numerous, close, crowded, and unequal; the larger are thickest from the centre of the calice to the axial space, which they bound with perpendicular edges; they are thin externally and distinctly granular. There are many smaller septa, which are thickest at the margin, and become very thin near the axis, where they are joined laterally by still smaller ones; after the junction, a palus, in the form of a rounded lobe, exists before them. Occasionally minute pali are found on the smallest septa. There are about 248 septa, and they are arranged in multitudes of sets of three small between two larger ones, a rudimentary septum existing also at the margin. The synapticulæ are small and frequent.

Height of corallum $\frac{8}{10}$ inch.

Length of calice $1\frac{7}{10}$ inch; breadth of calice $1\frac{3}{10}$ inch.

Locality. Jhirk, Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate VIII.

Fig. 3. The corallum: natural size.
4. Septa and pali: magnified.
5 & 6. Septa: magnified.

Genus TURBINOSERIS.

Turbinoseris, *Duncan, Quart. Journ. Geol. Soc.* 1873, vol. xxix. p. 558.

1. **Turbinoseris Ranikoti**, *Duncan*. Plate VII, Figs. 10, 11.

The corallum is conical, compressed, and has a curved, rounded pedicel, with a scar of former adhesion.

The calice is elliptical, with a sharp margin, a very deep fossa, an elongate axial space, and very numerous, close, unequal, non-exsert septa. The larger septa are stout and reach the axial space, which they bound with their perpendicular inner margins; the next in size also reach the axial space; others, large, do not pass in thus far; and between the larger septa are three small and close ones, which sometimes reach halfway into the calice. The number of the series of these septa thus bounded is great; and altogether there are about 288 septa, and they are finely granular on the sides, rounded and minutely granular above. The exceedingly close, small septa at the margin are connected by synapticulæ.

The costæ are very numerous, corresponding to the large and small septa; but they are subequal, small, slightly prominent and separate, and are minutely granular near the calice. Lower down they are closer, less projecting, less numerous, often wavy and granular, and they may be represented by rows of granules; near the curved pedicel, and on it, they are more distinctly large and small, much fewer in number, and less distinct. The epitheca exists as ridges and as indefinite structure, in which the costæ are faintly seen. Synapticulæ are exceedingly common between the costæ. There is no columella.

Height of corallum $1\frac{6}{10}$ inch.
Length of calice 2 inches.
Locality. Hills east of Lynyan, Ranikot group. Survey-number G $\frac{289}{137}$.

Illustrations of the Species in Plate VII.

Fig. 10. The corallum: natural size.
11. The costæ: magnified.

2. **Turbinoseris epithecata**, *Duncan*. Plate VII, Figs. 8, 9.

The corallum is short, trochoid, compressed, with an incurved, small pedicel. The calice is widely open, elliptical, and slightly irregular in its margins, at the sides, where it is sharp and not rounded off. The septa are in six cycles, and are slender and alternately large and small; usually there are three smaller between two larger septa; they are often rather wavy, very exsert, and there are extremely numerous synapticulæ.

The costæ are only visible close to the calicular margin, and for a short distance, perhaps $\frac{1}{12}$ inch; and they merge into a dense, granular, broken-up-looking epitheca, which covers all the rest of the corallum, having here and there indications of costal striæ.

Height of corallum $\frac{8}{10}$ inch.

Length of calice $1\frac{4}{10}$ inch.

Locality. Three miles west of Lynyan, Ranikot group. Survey-number G $\frac{280}{126}$..

Illustrations of the Species in Plate VII.

Fig. 8. Part of the epitheca: magnified.
9. Septa: magnified.

A variety of this type has a larger corallum, nipped in at the sides, and with a nearly rounded-off base, with barely a vestige of a peduncle. The costal lines are visible, underlying the epitheca, or more or less uncovered by it.

It is from the same locality.

3. TURBINOSERIS HAIMEI, *Duncan.* Plate VII, Figs. 4–7.

The corallum is simple, short, conical, turbinate, compressed, and has a much-bent and incurved pedicel. The calicular surface is long, elliptical, slightly reentering at one spot, and on an even plane. The margin is rounded; the axial fossa is long and deep, and the septa dip down into it.

The septa are numerous, close but not crowded, slightly exsert (especially the larger), and alternately large and small. There are numerous arrangements of eight septa, one being large and long, an intermediate shorter, two others are on either side, less large and long, and there are four small and short intermediate laminæ. There are six cycles of septa.

There is no columella, and the synapticulæ are rather numerous. The costæ are markedly alternately large and small, prominent and low, and they are so over the whole of the inferior portion as well as above.

The direction of the costæ is peculiar: on the surface opposed to the curvature of the pedicel they are parallel, and reach in right lines from the calicular margin to the pedicel, converging gradually and diminishing in number; but the costæ of the sides of the coral do not converge to the pedicel, they pass obliquely backwards and join the outer costæ of the portion just mentioned along a broad line. The costæ are most prominent near the margin; a few synapticulæ exist between them. There is no epitheca.

Length of the calice $1\frac{5}{10}$ inch; breadth of the calice 1 inch.

Height of the coral $\frac{8}{10}$ inch.

Locality. Three miles west of Lynyan, Ranikot group. Survey-number G $\frac{280}{126}$.

Illustrations of the Species in Plate VII.

Fig. 4. The corallum, natural size, in outline.
5. Side view.
6. The septa: magnified.
7. The junction of the costæ: magnified.

4. TURBINOSERIS INDICA, *Duncan.* Plate VII, Figs. 1–3.

The corallum is simple, short, conical, slightly curved, and pedicellate below, and largely expanded at the elliptical shallow calice, which has a waved margin. The pedicel broadens out rapidly, and is slightly bent in the plane of the minor axis. The costæ are subequal, minutely granular above, barely projecting, and their surface here and there merges into a kind of broken granular epitheca. Near the calicular margin the costæ are the most distinct; and close to it they become more prominent, granular, and alternately large and small, and slightly more separate. There is an obliquity of their direction in some places. A few synapticulæ exist between some of the costæ.

The calice is open, shallow, and usually has an incurved margin. The septa are very numerous, close, alternately large and small, long, level, granular, and without any definite cyclical arrangement; they join by their sides towards the centre of the calice, and the smaller are wavy. A false columella is formed by the septal ends. There are about 192 septa, and the synapticulæ are numerous and slender.

Breadth of calice $1\frac{4}{10}$ inch; length of calice $1\frac{6}{10}$ inch.

Height of corallum $1\frac{2}{10}$ inch.

Locality. Three miles west of Lynyan, Ranikot group. Survey-number G $\frac{280}{128}$.

Illustrations of the Species in Plate VII.

Fig. 1. The corallum: natural size.
2. Costæ: magnified.
3. Septa and synapticulæ: magnified.

5. Turbinoseris elegans, *Duncan.* Plate XVI, Figs. 3, 4.

The corallum has a widely open, irregular-shaped calice, and a more or less conical base. The axial space is elongate, and there is a region around it where there is a kind of indistinct fossa; around this the calice is undulating, more or less, to the everted margin.

The septa are very numerous, close, small, often curved, and a few reach the long axial space. Some of these are larger than the others, and between them there are smaller septa, and to these still smaller unite. All are stouter externally, and at the everted edge become covered with epitheca. At the margins the larger and broadest septa, after passing inwards, unite to form the surface near the axial space. There are more than six cycles of septa. Synapticulæ are seen at the edge; and the epitheca is dense, plain, or slightly and irregularly granular.

Height of the corallum from the base is $1\frac{3}{10}$ inch, and the greatest diameter of the calice $2\frac{4}{10}$ inches.

Locality. Jhirk, in the Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate XVI.

Fig. 3. The corallum, side view: natural size.
4. Some septa: magnified.

These species of the genus *Turbinoseris* are more or less allied to those found in the Eocene of St. Bartholomew, West Indies. The genus does not appear to have European Tertiary allies.

Genus CYCLOLITES.

Cyclolites, *Lamarck, Syst. des Anim. s. Vert.* p. 369.

1. **Cyclolites alpina**, *D'Orbigny* sp. Plate XIII, Figs. 8, 9.

This European Eocene coral is noticed by D'Orbigny as *Funginella alpina*, Prodr. de Paléont. t. ii. p. 403 (1850). Subsequently Milne Edwards and Jules Haime noticed it as a doubtful *Cyclolites* in 1851; and, finally, Jules Haime determined this to be its proper generic position in 1854.

The specimen from Sind is from the Ranikot group, three miles west of Lynyan. Survey-number G $\frac{280}{130}$.

It is a broad and very shallow form, with thin margins. The lower surface is slightly projecting at the position of the peduncle, and shows feeble circular ridges of epitheca. The epitheca is delicate and permits the costæ to be seen. The upper surface is very flat. The septa are very numerous, crowded, and unequal; there are more than six cycles of them. The coral is circular in outline. The breadth of the calice is $1\frac{9}{10}$ inch and the height about $\frac{3}{10}$ inch.

Illustrations of the Species in Plate XIII.

Fig. 8. The corallum: natural size.
9. Septa: magnified.

2. **Cyclolites Ranikoti**, *Duncan*. Plate XVII, Figs. 5, 6.

The corallum is circular in outline and concave below, where there is a feeble epitheca barely marked with concentric rings. Above, the coral is slightly convex, with rather a blunt marginal edge. The fossa is very small and circular. The septa are thin, not very close (for the genus), furnished with numerous and visible synapticulæ, unequal, usually straight and plain, having a sharp keen edge. The smaller septa cling to the margin, and the larger are broadest near the fossa; and there are in all from 280 to 300 septa.

Height of corallum $\frac{3}{20}$ inch; breadth $\frac{8}{10}$ inch.

Locality. Three miles west of Lynyan, Ranikot group. Survey-number G $\frac{280}{126}$.

Illustrations of the Species in Plate XVII.

Fig. 5. The corallum, side view: magnified.
6. Some septa, magnified, showing synapticulæ.

Cyclolites Ranikoti, *Duncan*. Variety.

A variety of the species occurs at Jhirk, in the Ranikot group. Survey-number G $\frac{280}{124}$. It has smaller septa, which are rounded where free, instead of being sharp-edged; moreover, the septa are dentate in the fossa.

3. **Cyclolites crenulata**, *Duncan*. Plate XVII, Figs. 3, 4.

The corallum is circular in outline, flat beneath, and is marked with a strong epitheca with bourrelets. The upper surface is slightly convex and has a small circular fossa. The septa are unequal, close, about 280 in number, thicker near the fossa than elsewhere, and the free surfaces of all are distinctly ornamented with a flat crenulation, the lines of which are across the septa, making a great number of rectangular, square, and irregular markings. The septa pass deeply down the sides of the fossa.

The height of the coral is under $\frac{2}{10}$ inch, and the breadth is $\frac{9}{10}$ inch.

The locality whence this fossil was derived is the hills east of Lynyan, in the Ranikot group. Survey-number G $\frac{280}{137}$.

Illustrations of the Species in Plate XVII.

Fig. 3. The coral, side view: magnified.
4. A portion of the calicular part: magnified.

4. Cyclolites Vicaryi, *Haime*. Plate XVII, Figs. 1, 2.

This was the only Cyclolite described by D'Archiac and Haime (*op. cit.* p. 192); and the following is the diagnosis:—

The corallum is circular in outline and short; the inferior face is concave and covered with a well-developed epitheca, marked with slight concentric "bourrelets" and having a slight median projection. The upper surface is slightly convex, with a shallow, circular central fossa. There appear to be six cycles of septa complete; all the septa are very close, very thin, straight, and subequal. The height is less than $\frac{1}{4}$ inch and the diameter about $\frac{3}{4}$ inch.

In the magnified view of the calicular surface (plate xii, fig. 8 *b*) D'Archiac and Haime indicate a moniliform condition of the free edges of the larger septa, and that whilst the majority of the septa do not reach more than halfway to the central fossa, a number of systems do, and that they consist of two larger septa with three smaller between them, and of these three the central one alone passes to the fossa. These are important additions to the diagnosis, especially when at least eight other forms of closely allied *Cyclolites* are found in Sind.

In the two specimens collected by the Indian Geological Survey from three miles west of Lynyan, Ranikot group (Survey-number $\frac{280}{128}$.), the breadth is greater than in the type in one, and the height in relation to the proper breadth is less in the other. The general septal arrangement is seen, and the faint crenulation and beading of the larger septa also; but the smaller septa have minute tubercles on them. The synapticulæ are well seen, and in one specimen some of the largest septa meet on the floor of the fossa.

Specimen 1. Breadth $\frac{3}{4}$ inch, height rather less than $\frac{1}{4}$ inch.

Specimen 2. Breadth $1\frac{1}{10}$ inch, height $\frac{1}{4}$ inch.

Illustrations of the Species in Plate XVII.

Fig. 1. Side view of the corallum: magnified.
2. The septa: magnified.

5. **Cyclolites anomala**, *Duncan*. Plate XVII, Figs. 13, 14.

The corallum is circular, thin, barely convex above, with a shallow fossa. Below it is flat with a median projection, and the epitheca is marked with concentric rings. The septa are numerous, not very close, thin, plain, unequal, and there is much union of groups of them near the fossa, into which depression very few enter.

Height $\frac{1}{12}$ inch; length $\frac{7}{10}$ inch.

Locality. Jhirk, in the Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate XVII.

Fig. 13. The coral from above.
14. Some septa: magnified.

6. **Cyclolites superba**, *Duncan*. Plate XVII, Figs. 11, 12.

The coral is elliptical in outline, very concave inferiorly, and nearly hemispherical above. The epitheca is stout and marked with concentric rings; and the fossa is small, shallow, and slightly elliptical.

The septa are very numerous, very unequal, and those which reach over the half distance to the fossa are spined bluntly when large and sharply when small. The synapticulæ are numerous.

Height rather over $\frac{5}{10}$ inch; length of base $1\frac{2}{10}$ inch, breadth $1\frac{1}{10}$ inch.

Locality. Three miles west of Lynyan, Ranikot group. Survey-number G $\frac{280}{126}$.

Illustrations of the Species in Plate XVII.

Fig. 11. The coral, side view.
12. Some septa: magnified.

7. **Cyclolites Haimei**, *Duncan*. Plate XVII, Figs. 9, 10.

The corallum is slightly elliptical in outline, decidedly convex above, with a large shallow fossa, which is nearly circular. The base is rather flat, but is slightly concave in the middle, and the epitheca is moderately stout and faintly marked concentrically. The septa are unequal, numerous, about 280 in number, close at the margins, not crowded elsewhere, rather thin, separate, and all except the smallest are ornamented on the edge with minute, rounded, and sharp spines. The synapticulæ are numerous and visible.

Height of coral $\frac{4}{10}$ inch; length $1\frac{5}{10}$ inch; breadth $1\frac{1}{10}$ inch.

Locality. Three miles west of Lynyan, Ranikot group. Survey-number G $\frac{280}{126}$.

Illustrations of the Species in Plate XVII.

Fig. 9. The coral: natural size.
10. Some septa: magnified.

8. **Cyclolites Altavillensis**, *Defrance*. Plate XVI, Fig. 11.

This Hauteville type is present in the Sind Eocene coral-fauna of Jhirk. The base is slightly convex and has been pedunculate; it is feebly epithecate. The margin is slightly crested; the calice is circular, subflexuous; and the fossa is circular. The septa are very numerous, even in the young form.

Locality. Jhirk, in the Ranikot group. Survey-number G $\frac{280}{1240}$.

Illustration of the Species in Plate XVI.

Fig. 11. The corallum, natural size, side view.

9. Cyclolites striata, *Duncan*. Plate XVII, Figs. 7, 8.

The corallum is circular in outline, nearly flat inferiorly, where the epitheca is ringed concentrically, and very slightly convex above. The fossa is very small and rather oval, and not very deep. The septa are exceedingly crowded and close, so as to present the resemblance to a series of radial striations; they are very thin, equal, excepting the higher orders, close to the margin, and plain, and are about 360 in number.

Height of coral slightly over $\frac{1}{10}$ inch; breadth of the base 1 inch.

Locality. Jhirk, in the Ranikot group. Survey-number G $\frac{280}{1240}$.

Illustrations of the Species in Plate XVII.

Fig. 7. Corallum from above: natural size.
8. Part of the upper surface, near the edge: magnified.

The presence of nine species of the genus *Cyclolites*, including the European *Cyclolites alpina* and *Cyclolites Altavillensis*, in the lowest Tertiaries of Sind, is very interesting, for it stamps the coral-fauna with an Eocene facies; and this is rendered most decided by the presence of some other species common in the Nummulitic strata of Europe.

Genus THAMNASTRÆA, *Lesauvage, amended.*

1. Thamnastræa Balli, *Duncan*. Plate XIX, Figs. 1–3.

The corallum when full-grown is very large, massive, convex above, fungiform, with a low, broad stalk having a broad base. In young forms the coral is very convex above and incrusting or concave below, and is thin.

The convex upper surface is covered with vast numbers of very small, shallow calices, connected by long and very converging, narrow linear costæ. The small size of the costæ is very striking in relation to the great dimensions of the corallum; and the restricted calicular areas and very superficial and extremely shallow fossæ are equally characteristic. Some six or seven septa really touch the small rudimentary columella, and each is formed by several septo-costæ; but they are all nearly equal in thickness, and are not close. There may be from sixteen to thirty-six of these joining septa, all being of different lengths and entering into the composition of other calices also. The synapticulæ are very numerous.

In some parts of this remarkable coral the calices become elongate in one direction, and a long septo-costate columella, joined by many septa, results.

Length of *three* calices and their costæ about $\frac{3}{10}$ inch.

Height of the full-grown corallum $2\frac{1}{2}$ inches; breadth $6\frac{1}{2}$ inches.

Locality. South-west of Jhirk, Ranikot series (Survey-number G $\frac{236}{165}$); and at Jhirk (Survey-number G $\frac{280}{124}$).

Illustrations of the Species in Plate XIX.

Fig. 1. A small corallum: natural size.
2. Calices: magnified.
3. A long calice: magnified.

Group MADREPORARIA PERFORATA.

Family MADREPORIDÆ.

Subfamily EUPSAMMINEÆ, M. Ed. & J. H.

Genus STEPHANOPHYLLIA.

Stephanophyllia, *Michelin, article* Astrée, *Dictionnaire des Sciences Nat., Supplem.* vol. i. p. 484.

1. STEPHANOPHYLLIA INDICA, *Duncan.* Plate VIII, Figs. 7–10.

The corallum is almost hemispherical, but is slightly depressed at the columellary portion. The base is circular in outline, slightly concave, and no traces of costæ are visible: there appears to be a perfectly plane surface.

The margin of the corallum is marked by trabeculæ and the origin of the septa, and there are about three rows of the horizontal series of them. The columellary space is flat, trabecular, and circular in outline. The septa are in six systems of four cycles: the primaries are the longest, and are separated from the others; the secondaries, not so stout as the primaries, are nearly as long, and are joined by the tertiaries not far from their axial end; and the higher orders unite to the tertiaries about midway in the calice. Usually each septum is the result of the union of two trabeculæ at the margin. The largest septa are straight and stout, and they have minute granules on their sides and upper margin.

Breadth of the corallum $\frac{3}{20}$ inch; height $\frac{1}{12}$ inch.

Locality. Jhirk, Ranikot group. Survey-number G $\frac{280}{124}$.

Illustrations of the Species in Plate VIII.

Fig. 7. Side view: natural size.
8. The corallum, from above.
9. The calicular surface: highly magnified.
10. The trabecular septa of the edge: highly magnified.

This small Stephanophyllian is remarkable for not having the costulate base seen in all other species; but it is possible that the form is seated on a thin foraminifer. The large size of the trabecular columella distinguishes it from *Stephanophyllia Bower-*

banki of the British Lower Chalk, whose septa are more curved and granular. It is nearer the Cretaceous species than *Stephanophyllia discoides*, M. Ed. & H., from the London Clay.

Family PORITIDÆ.

Genus LITHARÆA, *M. Ed. & J. H.*

Litharæa, *M. Ed. & J. H., op. cit.* p. 22.

1. LITHARÆA GRANDIS, *Duncan.* Plate XI, Figs. 11, 12, 13.

The corallum is elliptical in shape, convex above, and flat at the edge and concave in the middle below. The calices are large, hexagonal, or irregular in size and shape, and are shallow. The margins are stout and trabecular and are irregular in outline, angular or circular, being occasionally produced. The septa are stout, distant, plain, often wavy, and the larger form a trabecular columella with their inner ends; the secondaries and tertiaries often join. There are twelve large and twelve smaller septa, more or less developed in different calices. The laminæ are not very perforate. The floor of the calicular fossa is closed by dissepiments, which are not very perforate.

The base of the coral has no epitheca, but the costæ and an exotheca exist there in abundance.

The length of the corallum is 3½ inches, the height is rather over 1 inch. The breadth of the largest calice $\frac{5}{10}$ inch; $\frac{4}{10}$ inch is a common length.

Locality. South-west of Lynyan, Ranikot group. Survey-number G $\frac{289}{133}$.

Illustrations of the Species in Plate XI.

Fig. 11. Side view of corallum.
12. Costæ: magnified.
13. Part of the base: magnified.

This species is closely allied to *Litharæa epithecata*, nobis, from the Cretaceous olive shales of Jakhmari, described at p. 23. The absence of a definite epitheca and the size of the calices constitute nearly the only distinction, but it is a fair one.

Genus PORITES, *Lamarck.*

1. PORITES SUPERPOSITA, *Duncan.* Plate XIV, Figs. 5, 6.

The corallum is in the shape of an irregular nodule, with a small elliptical base, swollen and constricted sides, and a tumid convex upper surface. Lines of superposition occur, and the coral consists of a number of layers, one over the other, or of a central mass whose sides have grown in layers irregularly. The calices are not crowded, are but slightly polygonal, and often circular, for there is an unusual amount of trabecular tissue at the wall. The septa are close and crowded, rather short, not much thicker at the margin than within, irregular in their size and direction, many joining others; there are 24 of them, and pali exist in the form of bead-like points, the columella being scarcely distinguishable from them. The trabeculæ are close, and the septa are not very perforate.

Height of corallum $1\frac{4}{10}$ inch; breadth 1 inch; length $1\frac{8}{10}$ inch.

Breadth of a calice $\frac{1}{12}$ inch.

Locality. Jhirk, Ranikot group. Survey-number G $\frac{280}{134}$.

Illustrations of the Species in Plate XIV.

Fig. 5. The corallum: natural size.
6. A calice: magnified.

List of Species from the Ranikot Series which have been found elsewhere.

1. *Plocophyllia flabellata*, Reuss. From the district of S. Giovanni Ilarione, between the Valle di Chiampo and Montebello, Alps, Europe.
2. *Diploria flexuosissima*, D'Ach. S. Giovanni Ilarione.
3. *Astrocœnia nana*, Reuss. Monte delle Carrioli, Castel-Gomberto district.
4. *Astræa Morloti*, Reuss. Oberburg, Steiermark.
5. *Trochoseris difformis*, Reuss. Castel-Gomberto district.
6. *Cyclolites alpina*, D'Orb. Eocene of St. Bonnet, Faudon.
7. *Cyclolites Altavillensis*, Defr. Eocene, Hauteville.

Alliances of some of the Species found in the Ranikot Series with those of remote Areas.

1. *Trochocyathus corbicula*, Duncan, to *Trochocyathus sinuosus*, Brogn., Eocene of La Palarea and Friuli.
2. *Blagrovia simplex*, Duncan, to *Smilotrochus incurvus*, D'Ach., from S. Giovanni Ilarione, Alps.
3. *Stylina Reussi*, Duncan, to *Stylinæ* from Castel-Gomberto, but slightly only.
4. *Stylocœnia maxima*, Duncan, to *Stylocœnia macrostyla*, Reuss, from S. Giovanni Ilarione.
5. *Plocophyllia Sindiana*, Duncan, to *Plocophyllia gregaria*, Reuss, from S. Giovanni Ilarione.

Total number of species of fossil Corals from the Ranikot series, 50.

Species identical with those of European Eocene deposits containing *Nummulites planulatus* and *Cerithium giganteum*, 7.

Species allied closely to those of European deposits on the same and on slightly higher horizons, 5.

The most coralliferous strata in the Ranikot series are:—at Jhirk; south-west of Jhirk; hills east of Lynyan and west of Lynyan; Vero plain east of Kandaira; and hilly ground north-by-east of Pétiani.

VIII. *Description of the Fossil Corals from the Khirthar Series in the Nummulitic Deposits of Sind above the Ranikot Series.*

Of the sixteen species derived from localities in the Khirthar series, ten come from strata so high up that it is not satisfactorily determined whether they form the top of the Khirthar series or the base of the Nari series.

List of the Species of Madreporaria or Stony Corals from the Khirthar Series of Sind.

Section **MADREPORARIA.**

Group MADREPORARIA APOROSA.

Family TURBINOLIDÆ.

Subfamily TROCHOCYATHACEÆ.

Trochocyathus nummuliticus, *Duncan.*

Leptocyathus epithecata, *Duncan.*

Transition-group STYLOPHORINÆ.

Stylophora contorta, *Leymerie.*

Family ASTRÆIDÆ.

Subfamily STYLINACEÆ.

Stylina tertiaria, *Duncan.*

Subfamily ASTRÆACEÆ.

Montlivaltia Indica, *Duncan.*
Calamophyllia Indica, *Duncan.*
Latimæandra insignis, *Duncan.*
Hydnophora Maliriensis, *Duncan.*
Favia Maliriensis, *Duncan.*
Favia pedunculata, *Duncan.*
Astrocœnia numisma, *Defrance.*
Isastræa irregularis, *Duncan*, and a variety.
Pterastræa mirabilis, *Duncan.*
Plesiastræa eocenica, *Duncan.*

Group MADREPORARIA PERFORATA.

Family PORITIDÆ.

Porites Indica, *Duncan.*

Porites Pellegrinii, *D'Achiardi.*

Section MADREPORARIA.

Group MADREPORARIA APOROSA.

Family TURBINOLIDÆ.

Subfamily TROCHOCYATHACEÆ.

Genus TROCHOCYATHUS, *M. Ed. & J. H.*

1. TROCHOCYATHUS NUMMULITICUS, *Duncan.* Plate IV, Figs. 1–3.

The corallum is cyclolitoid in shape, circular in outline, depressed centrally at the axial space, slightly convex to the margin, very short, and either very slightly convex inferiorly or concave. The base is attached to a small Nummulite, and has a delicate epitheca, through which the costæ can be seen. The costæ are straight, numerous, unequal, and many reach the point of attachment, and there are three smaller ones between each pair of the longer.

The edge of the calice is perpendicular for a very short distance, and there the costæ are well seen; they are sharply granular laterally, and not very unequal in size. The smaller turn over the upper edge of the margin, and correspond with small septa which do not reach far inwards.

The calice, widely open, is crowded with septa and pali very closely placed. The septa are thin, moniliform from ornamentation at the edge, and unequal in length. There are five cycles, and all the orders except the highest have pali. The principal cycles are equal, but the primaries and secondaries have not the largest pali, and do not correspond with the largest costæ. The largest pali are long, stout, low, arched, and are higher than the septa, and they reach far towards the margin; the others are elongate ovals in shape.

The sides of the septa are granular. The axial space is circular in outline, moderately deep, and there is no columella.

The height of the coral is $\frac{1}{10}$ inch, and the breadth of the calice is rather more than $\frac{4}{10}$ inch.

In some of the corals the epitheca is dense, and the basal surface is concave, and the whole is not so bulky as in the type.

Locality. Gagar hill, east of Surjána, Khirthar group. Survey-number G $\frac{302}{114}$.

Illustrations of the Species in Plate IV.

Fig. 1. The base of the coral: natural size.
2. The base: magnified.
3. The calice: magnified.

Genus LEPTOCYATHUS, *M. Ed. & J. H.*

Leptocyathus, *M. Ed. & J. H., op. cit.* vol. ii. p. 80.

1. Leptocyathus epithecata, *Duncan.* Plate IV, Figs. 4–7.

The corallum is discoid, flat beneath, swollen at the margin, and with a sunken central fossa. Frequently attached to a Nummulite, the base is marked with linear costæ, and usually three small ones are placed between a pair of long ones, all being more or less masked by a pellicular epitheca which reaches to the edge of the calice; there the costæ project rather unequally, the primaries and secondaries being the most prominent. As they form the flank of the coral they become arched, distinct, granular, and preserve their arrangement in size. The septa correspond with the costæ, and the larger are exsert, arched above, very granular laterally, and long; they pass downwards, diminishing in size, to the axial space, where small broken-granular-looking pali terminate them and merge into a central columella. The middle septum of the three smaller between the pair of larger septa reaches far towards the centre, and the others less so, and the larger only have pali. The smaller series are not so high or arched; but all are granular laterally, and in some places the granules unite, simulating synapticulæ.

Height of the coral $\frac{1}{12}$ inch. Breadth of calice $\frac{1}{10}$ inch and less.

Locality. Gagar hill, Khirthar series. Survey-number G $\frac{302}{114}$.

Illustrations of the Species in Plate IV.

Fig. 4. The base: natural size.
5. Ditto: magnified.

Fig. 6. Septa and one of the pali in front.
7. Costæ: magnified.

This is rather an aberrant form of the genus *Leptocyathus*, and the glazed-looking epitheca is characteristic.

Transition-group STYLOPHORINÆ, M. Ed. & J. H.

Genus STYLOPHORA, *M. Ed. & J. H.*

1. STYLOPHORA CONTORTA, *Leymerie.* Plate XVIII, Figs. 21, 22.

There is a small branch of this well-known Eocene coral in the Khirthar group in deposits "near Petiani," west of Kotri. It was found also by D'Archiac and J. Haime in Sind; and its other localities are the Eocene of the West Indies, and La Palarea, Foujoncouse, Corbières, &c. in Europe. Survey-number G $\frac{280}{77}$.

Illustrations of the Species in Plate XVIII.

Fig. 21. The branch: natural size.
22. Calices: magnified.

Family ASTRÆIDÆ.

Subfamily STYLINACEÆ.

Genus STYLINA, *Lamarck.*

1. STYLINA TERTIARIA, *Duncan.* Plate VI, Figs. 1, 2.

The corallum has a large and irregular upper surface, which, on the whole, is almost flat, and the height of the mass is under an inch. The calices are small, numerous, irregularly distant, crateriform, with a widely open shallow fossa. The walls rise suddenly from the almost plain intercalicular space, and do not narrow over-much, and they are marked by thin, distinct, wide-apart costæ. In some calices there are 18 well-developed costæ, and some smaller exist between the larger. There are two cycles of septa, and part of a third in some systems. The columella is very small and styliform, but distinct. The intercalicular space is either plain, costulate, or minutely granular.

Breadth of type 2 inches. About 8 calices and interspaces occupy 1 inch of length.

Locality. Maliri, south of Chotra, at the top of the Khirthar group or base of the Nari. Survey-number G $\frac{302}{92}$.

Illustrations of the Species in Plate VI.

Fig. 1. Part of corallum: natural size.
2. Calices: magnified.

Subfamily ASTRÆACEÆ.

Genus MONTLIVALTIA, *Lamouroux.*

1. MONTLIVALTIA INDICA, *Duncan.* Plate X, Figs. 5–7.

The corallum is large, low, free, and is compressed slightly at the sides. The calice is widely open, elliptical, and very slightly deformed. The fossa is shallow, and the axial fossula is elongate and limited by the septal ends. The margin is rather sharp. The septa are very numerous, being more than 400; they are exceedingly thin, long, well separate, subequal, and united often by dissepiments as thin as themselves. Near the margin some small septa intervene. The septa are slightly spinulose or crenulate at the free edge.

The base is convex, and more so from side to side than is the long diameter; there is a delicate peduncle surrounded by a circular ridge of epitheca, and this is succeeded by other broader and more prominent epithecal ridges, some of which cover the costæ to close to the margin.

The costæ are visible at the pedicel, and here and there between the epitheca; they are as delicate and thin as the septa, are numerous and subequal, and united by exotheca.

Height of the coral 1 inch; length 3 inches; breadth $2\frac{2}{10}$ inches.

Locality. North of Maliri, Khirthar group. Survey-number G $\frac{302}{99}$.

Illustrations of the Species in Plate X.

Fig. 5. The corallum: natural size.
6. The base.
7. Part of septa and endotheca: magnified.

Genus CALAMOPHYLLIA, *M. Ed. & J. H.*

1. CALAMOPHYLLIA INDICA, *Duncan.* Plate XIX, Figs. 6, 7.

The corallum is tall, and consists of a bundle of corallites tolerably closely placed together, branching once here and there, and being more or less deformed, and both angular and rounded. The costæ are not visible; the septa are thin, and in about four cycles; the columella is very small. The endotheca is well developed, and there is a slight swelling of the long corallites here and there. The wall is stout.

Height of the corallum $4\frac{1}{2}$ inches. Breadth of a calice $\frac{3}{10}$ to $\frac{4}{10}$ inch.

Locality. Hindi hill, Upper Khirthar beds. Survey-number G $\frac{302}{94}$.

Illustrations of the Species in Plate XIX.

Fig. 6. The corallum: natural size.
7. A transverse section of a corallite: magnified.

The species is allied to *Calamophyllia fasciculata,* Reuss, = *C. flabellum* from the Upper Nummulitic of Oberburg.

Genus LATIMÆANDRA, *D'Orbigny.*

1. LATIMÆANDRA INSIGNIS, *Duncan.* Plate XX, Fig. 10.

The coral is large, flat, thin, circular in outline, and pedunculate. A very feeble epitheca exists, and radiating costal striæ are seen through it or are uncovered. The series, which are very shallow, broad, comparatively straight, except here and there where there are leaf-like offshoots, radiate from the centre of the upper surface to the margin. The valleys are shallow and broad, have a distinct axial line, but no columella; and the septa, large and wide apart near the line, are more numerous, and sometimes alternately very small and large, at the sharp yet low colline top. The larger septa have a clubbed end; and there are about twelve of them in the space of $\frac{1}{2}$ inch.

Height of the coral $1\frac{3}{10}$ inch; breadth $5\frac{1}{4}$ inches.

Length of series $1\frac{1}{2}$ inch to $\frac{3}{4}$ inch; breadth $\frac{1}{2}$ inch.

Height of valleys $\frac{1}{10}$ inch.

Locality. Maliri, at the top of the Khirthar series or base of the Nari. Survey-number G $\frac{302}{92}$.

Illustration of the Species in Plate XX.

Fig. 10. Half of the corallum: natural size.

Genus HYDNOPHORA, *Fischer de Waldheim.*

1. Hydnophora Maliriensis, *Duncan.* Plate XIX, Figs. 11, 12.

The corallum is very massive, flat and costulate below, gibbous above, and covered with moderately large, sharp-edged, broad-based collines, very irregularly placed and sized. Many collines are oblique, and the valleys are deep, the septa being large, and alternately large and small. The columella is absent.

Height of the coral $2\frac{1}{4}$ inches; length of specimen 7 inches.

The longest colline is $\frac{8}{10}$ inch, and the distance from one colline to the next is about $\frac{3}{10}$ inch.

Locality. Maliri, south of Chotra, at the top of the Khirthar series or base of the Nari. Survey-number G $\frac{302}{92}$.

Illustrations of the Species in Plate XIX.

Fig. 11. A part of the corallum: natural size.
12. A colline: magnified.

Genus FAVIA, *Oken.*

1. Favia Maliriensis, *Duncan.* Plate VI, Figs. 3, 4.

The corallum is massive, large, thick, and somewhat flat at the base, and convex above and sloping at the sides. The calices are excessively irregular in size, shape, projection, depth, and in their details. The costæ are larger than the septa, and usually unite with those of the next calice, but a line of depression sometimes intervenes; they are distinct, crowded, minutely granular, and subequal. Every alternate costa corresponds with a rudimentary or else with a very small septum. The septa are smaller than the costæ, spread over the floor of the deep calices, are slender alternately, and usually enlarge near the axial space, so as to form part of the small spongy columella. There are three cycles or 24 septa in the smaller calices, and in the long and deformed ones the fourth cycle may be reached. The costæ form a very prominent part of the coral, and they cover a broad space between the calices as a rule.

Length of largest calices, including costal prolongations, $\frac{8}{10}$ inch.

Depth of calices often $\frac{2}{10}$ inch.

Locality. Maliri, south of Chotra, at the top of the Khirthar beds or base of the Nari series. Survey-number G $\frac{302}{92}$.

Illustrations of the Species in Plate VI.

Fig. 3. Calices: magnified.
4. Other calices, magnified, showing the large costal continuation from one calice to the other.

2. Favia pedunculata, *Duncan*. Plate VI, Figs. 5, 6.

The corallum is rather convex above, thin at its circular edge, and broadly pedunculate, there being also a delicate epitheca. The calices are exceedingly irregular in shape, size, and depth, but all have close, low, flat, broad granular costæ, which are subequal and slightly separate at the margin, and a distinct line or depression limits one calice from another, and usually, but not invariably, interferes with direct costal communication. The calices, long, hexagonal, square, irregular or circular in outline, are shallow and widely open. The septa, about 60 in number, in the largest calices, arise from the nearly equal costæ, and, as a rule, are alternately large and small, the largest being the longest and reaching a columella: they are all slight in breadth and height, and are often curved sideways. The columella is trabecular, and assumes a broken lamellar shape in long calices.

When calices unite, the crest may be sharp and the line wanting, or it may be rather flat, and then the limiting line is distinct.

The breadth of the corallum is 4 inches; height $1\frac{5}{10}$ inch.

Length of longest calice $\frac{7}{10}$ inch.

Locality. Maliri, south of Chotra, at the top of the Khirthar group or base of the Nari series. Survey-number G $\frac{302}{92}$.

Illustrations of the Species in Plate VI.

Fig. 5. Part of the upper surface of the corallum: natural size.
6. Calices: slightly magnified.

Genus ASTROCŒNIA, *M. Ed. & J. H.*

1. Astrocœnia numisma, *Defrance*, sp. Plate VI, Figs. 13–15.

The corallum is discoid and very thin, subpedicillate, or placed on a small nummulite, and slightly convex above, with thin edges. The epitheca is in delicate circular ridges, and costæ are faintly visible. The calices are placed with great regularity, and they appear to have increased in size and to bud at the edge; they are nearly equal in size, and are regularly hexagonal and shallow. The colnmella is cylindrical, sharp, and projects. The septa are usually 20 in number, and are alternately large and small. The intercalicular spaces are small and costulate.

Breadth of the largest corallum $\frac{6}{10}$ inch; height $\frac{1}{10}$ inch.

Locality. Gagar nala, N.E. of Bula Khan's Thana, and east of Surjána, Khirthar series. Survey-numbers G $\frac{302}{108}$, G $\frac{302}{114}$.

This beautiful species has also been found near Gap, in the district of Nice, in the Nummulitic of the Hautes Alpes.

Illustrations of the Species in Plate VI.

Fig. 13. Upper part of coral: natural size.
14. Side view.
15. Calices: magnified.

Genus ISASTRÆA, *M. Ed. & J. H.*

1. Isastræa irregularis, *Duncan.* Plate XIV, Fig. 1.

The corallum is large, irregular in shape, convex above, and has a large peduncle below, where there is an epitheca.

The calices are exceedingly variable in shape and size; and this is irrespective of the intramarginal gemmation which prevails. Some are irregularly oval or polygonal, and these are the largest; others are in hexagons or pentagons and are smaller. The margins are united, and the septo-costæ are rather wide there. The calices are deep about the edges; but the floor of the fossa is often flat. The septa are not numerous, and 18, 24, or 36 are the usual numbers, but when there are many very small septa there are four cycles; the primaries are the largest, and are short and straight, and sometimes are swollen within; and the others, especially the smallest kinds, unite with the larger septa. Usually the septa are alternately large and small, and the smallest are often crowded between the larger. The costal end of the septa is slightly swollen. A false columella exists, produced by the inner termination of the septa, and in some calices it is almost lamellar. The epitheca is plain.

Breadth of corallum 3–4 inches; length $4\frac{1}{2}$–8 inches; height $1\frac{3}{4}$ inch.

Length of calices $\frac{4}{10}$ to $\frac{1}{10}$ inch.

Locality. Maliri, top of the Khirthar series or base of the Nari. Survey-number G $\frac{302}{92}$.

Illustration of the Species in Plate XIV.

Fig. 1. Some calices: slightly magnified.

Isastræa irregularis, *Duncan.* Variety. Plate XIV, Fig. 2.

A large, massive corallum, covering many square inches, gibbous more or less on the surface, and about from 1 to 3 inches thick. The calices are smaller and more regular than in the type, and the principal septa are of uniform breadth from the broad and often granular margin to the false columella.

Locality. Maliri, top of the Khirthar group or base of the Nari. Survey-number G $\frac{302}{92}$.

Illustration of the Variety in Plate XIV.

Fig. 2. Some calices: magnified.

Genus PTERASTRÆA, *M. Ed. & J. H.*

1. Pterastræa mirabilis, *Duncan.* Plate V, Figs. 7, 8.

The corallum is massive, and more or less incrusting in its habit; it is rather irregular on the calicular surface; and the calices have their septa arranged partly in four, five, or six unequal lozenge-shaped or triangular masses, one lozenge belonging, as it were, by the continuity of its septa, to a neighbouring corallite. The massed septa are on a higher level than the others, which are in grooves between them or in depressions. Usually there are stout linear masses of several septa also, or a single large septum may form one.

The septa are close, crowded, rather irregular in their course, and there may be from one to six in the elevated "septal masses." In the intermediate spaces they are of the same shape, and may equal the others in number. Several septa unite in the axial space, producing a small nodule simulating a styloid columella. The limits of the calices are indefinite in consequence of the intercalation of the groups of septa, of which probably there are four cycles.

The synapticulæ are numerous and close, and may be seen on the calicular surface; and they are equally numerous between the long septal laminæ in longitudinal section.

There is no other endotheca or epitheca.

The coral covers some inches of surface and is tall.

The calices are not in series, and about six of them occupy the length of an inch.

Locality. Maliri, south of Chotra, at the top of the Khirthar beds, or at the base of the Nari series. Survey-number G $\frac{302}{92}$.

Illustrations of the Species in Plate V.

Fig. 7. Corallum, upper surface: natural size.
8. Calices: magnified.

Genus PLESIASTRÆA, *M. Ed. & J. H.*

1. Plesiastræa Eocenica, *Duncan*. Plate XIX, Figs. 8–10.

The corallum is large, massive, plain beneath, and rather gibbous above; or it may be boldly convex above, and low and broadly pedunculate.

The calices, very unequal in size, are usually circular in outline, separated by a distinct groove and are slightly raised, the margin occupied by the junction of the costæ and septa being circular, broad, and overhanging the calices. Some calices, where there is much crowding, are deformed. The calices are, when perfect, rather deep, and there is a small columella and an imperfect row of pali, which are usually before the septa of perfect cycles, except the tertiaries; they are small, and but little broader and higher than the septal ends. The septa, never in four complete cycles, are thin, not often straight, and are not exsert. The costæ are much larger than the septa, form a rim to the margin, and are subequal, the primaries being distinguishable by their length: all are close, crowded, slightly rounded, not spined, and are distinct from those of the neighbouring corallites. The thin septa and the thick costæ are very characteristic.

Height of the corallum 3 inches; length 8 inches.

There are about three calices and their costæ to the length of 1 inch. The costal rim is $\frac{1}{10}$ inch broad in many calices.

Locality. Northern end of Watwáro range, between Trak and Damaj; top of the Khirthar or base of the Nari series. Survey-number G $\frac{302}{89}$.

Illustrations of the Species in Plate XIX.

Fig. 8. Calices: natural size.
9. „ : magnified.
10. A diagram of a septum and palus.

Probably a fungiform coral found at between Tong and Baili belongs to this species. Another convex block is from Mál Mohori.

Without the pali this coral would pass for a species of *Phyllocœnia*; and it is very probable that the fossil corals of Sind which were formerly associated with that genus really belong to *Plesiastræa*.

Group MADREPORARIA PERFORATA.

Family PORITIDÆ.

Genus PORITES.

1. Porites Indica, *Duncan.* Plate V, Figs. 12, 13.

The corallum is massive, and has a broad and irregularly gibbous surface. The calices are shallow, open, but slightly separate, hexagonal or pentagonal, or are irregular in outline. The septa are not crowded, and are rather equal: the primaries are the longest and largest, and the secondaries are slightly less; there is frequently union between the tertiaries or between them and the secondaries, and all have a few nodular granulations on their free edges. There are indefinite pali, either as nodules or as trabeculæ, around the rather wide axial space, which is filled by a trabecular columella.

There are three cycles of septa in some systems, but not in all. The coral is some inches in length and breadth.

The calices are usually from $\frac{1}{12}$ to $\frac{1}{10}$ inch in breadth.

Locality. Maliri, south of Chotra, top of the Khirthar beds or base of the Nari series; Mál Mohori, same horizon. Survey-number G $\frac{302}{92}$.

Illustrations of the Species in Plate V.

Fig. 12. A part of the coral: slightly magnified.
13. Calices (magnified) and portions of costæ.

2. Porites Pellegrinii, *D'Ach.* Plate V, Figs. 14, 15.

There is a nodular coral in the series from Sind whose calices resemble those of D'Achiardi's species, but the pali are not so distinct. The condition of the specimen is indifferent, and the knob on the septa nearest the axial space is the true palus. The septa are fewer than in the type, which is from San Giovanni Ilarione. The species is also mentioned by Reuss, and figured by him from that locality.

Locality. Sind; Mál Mohori, top of the Khirthar group or base of the Nari. Survey-number G $\frac{302}{90}$.

Illustrations of the Species in Plate V.

Fig. 14. The corallum.
15. Some calices: magnified.

List of the Species of Fossil Corals from the Khirthar Series which are identical with those of European and other Nummulitic deposits.

Stylophora contorta, Leymerie. At La Palarea and Foujoncouse, in Europe, and St. Bartholomew, West Indies.

Astrocœnia numisma. At Gap, Nice.

Porites Pellegrinii, D'Ach. S. Giovanni Ilarione.

Species which are allied to others in Europe.

Calamophyllia Indica, Duncan, to *Calamophyllia fasciculata*, Reuss (= *C. flabellum*, Reuss), from the Upper Nummulitic of Oberburg.

Hydnophora Maliriensis, Duncan, to *Hydnophora venusta* (Catullo), Nummulitic of Europe.

Porites Indica, Duncan, to *Porites micrantha*, Reuss, from Crosara, Oberburg.

The number of species of fossil Corals found in the Khirthar series is sixteen. The species common to it and the European and West-Indian Eocene is three, and there are three allied species.

IX. *Description of the Fossil Corals of the Nari Series of Sind.*

List of the Species of Madreporaria or Stony Corals from the Nari Series of Sind.

Section **MADREPORARIA.**

Group MADREPORARIA APOROSA.

Family TURBINOLIDÆ.

Subfamily TROCHOCYATHACEÆ.

Trochocyathus Burnesi, *J. Haime.*
———— nummiformis, *Duncan.*
———— nummiformis, 2 varieties, *Duncan.*
Trochocyathus Nariensis, *Duncan*, and a variety.
———— cyclolitoides, *M. Ed. & J. Haime.*
Blanfordia nummiformis, *Duncan.*

Transition-Group STYLOPHORINÆ.

Stylophora pulcherrima, *D'Achiardi.*

Family ASTRÆIDÆ.

Subfamily EUSMILINÆ.

Trochosmilia varicosa, *Reuss.*
———— Oldhami, *Duncan.*
Trochosmilia Dharanensis, *Duncan.*

Subfamily STYLINACEÆ.

Stylocœnia Taurinensis, *M. Ed. & J. Haime.*

Subfamily ASTRÆACEÆ.

Montlivaltia Vignei, *D'Arch. & J. Haime.*
Dasyphyllia gemmans, *Duncan.*
Rhabdophyllia Nariensis, *Duncan.*
Leptoria concentrica, *Duncan.*
Mæandrina Medlicotti, *Duncan.*
Prionastræa insignis, *Duncan.*
——— tenuiseptata, *Duncan.*

Family FUNGIDÆ.

Cycloseris Perezi, *M. Ed. & J. Haime.*
Cyclolites orientalis, *Duncan.*

Group MADREPORARIA PERFORATA.

Family PORITIDÆ.

Litharæa nodulosa, *Duncan.*

Section MADREPORARIA.

Group MADREPORARIA APOROSA.

Family TURBINOLIDÆ.

Subfamily TROCHOCYATHACEÆ.

Genus TROCHOCYATHUS, *M. Ed. & J. H.*

1. TROCHOCYATHUS BURNESI, *J. Haime.* Plate XVIII, Figs. 1–6.

This coral was described by J. Haime in D'Archiac's Hist. des progr. de la Géol. t. iii. p. 226 (1850), and subsequently it was noticed and drawn in their description of the Corals from Sind (p. 183). It was said to come from the Chaine d'Hala (Sinde); but the locality of derivation in this hypothetical mountain-chain is not stated. No perfect specimen is amongst those collected in the Geological Survey of the country; but a fractured coral from the Nari group evidently is a variety of it. The following is the description by J. Haime:—

The corallum is very short, subcyclolitoid, circular, the inferior surface slightly convex, pedicellate, and hollowed slightly centrally at the base into a little round fossula. The costæ are straight, distinct, and the primaries and secondaries are equal and project slightly; there is not much difference as regards the size of the others, and they are very close and finely granular, and nearly flat. The calice is relatively rather deep, and has a wide fossa. There are five complete cycles of septa; and the costæ are straight, narrow, exsert slightly, and rounded externally, and tolerably thin. Those of the first three cycles are subequal, and the others are slightly smaller, and all are granular and striated at the edge. The deeply seated columella is but slightly developed. The pali are short, moderately broad, rounded, and about the thickness of the septa to which they belong; but they are the largest when before the higher orders of septa, and those before the penultimate septa are bilobed. The last cycle of septa has no pali. The diameter of the coral is 2 centimetres, and the height 6 millimetres (that is, ⅘ inch and about ¼ inch).

The coral is figured on plate xii. fig. 2, *a*, *b*, *c*, of the work above mentioned; and views of the side and of the base are reproduced here.

Illustrations of the Species in Plate XVIII.

Fig. 1. Side view of the corallum: natural size.
2. The base: slightly magnified.
3. A side view of the costæ: magnified.
4. The ornamentation of a septum: magnified.

The variety has the general shape of the type; but the epitheca, which appears to be pellicular, is merged into a confused outer surface in which the costæ are feebly seen. The septal arrangement is not complete in its cycles, and two large septa have nine others between them; but the ornamentation is the same. The granulation of the septa is very close and marked. The pali are small, and the columella barely exists.

Height of the corallum $\frac{8}{10}$ inch; breadth 1 inch.

Locality. Near Raduk, ten miles S.S.E. of Jhángára (Survey-number G $\frac{302}{74}$); and also west of Bhágathoro Hill, south of Sehwán (Survey-nnmber G $\frac{226}{76}$).

Two young corals belong to this variety, and are $\frac{5}{10}$ and $\frac{8}{10}$ inch in length. The external texture of the base is remarkable, and is of that broken, mosaic kind which is so often seen in these Sind corals. In the smaller one the costæ are more distinct.

Fig. 5. A young coral of the variety. The epitheca: magnified.
6. A smaller one placed on a nummulite. The base: magnified.

All were from the same locality.

2. TROCHOCYATHUS NUMMIFORMIS, *Duncan*. Plate XX, Figs. 1–4.

The corallum is very flat, circular in outline, slightly convex above and below, with rather a sharp margin. The calice is widely open, shallow, and with a small, slightly elliptical central space, where there is a papillate columella. The septa are excessively crowded, and there are numerous repetitions of series composed of three small septa, of which the central is the largest, placed between two larger. This arrangement is repeated so often that there are at least six cycles of septa, or nearly 200 of them. The primaries and secondaries are larger than the others and are subequal; the tertiaries are next in size, and then the rest diminish according to the order. The larger septa are as thick midway in their course as at the margin, and the smallest are slightly wavy in their course and join the larger ones. The larger septa reach close to the edge of the axial space, and end in large, lobed pali, those of the primaries and secondaries being subequal and larger than those of the other orders. The innermost pali, about as thick as the septa, form a very marked circle; and the outermost are smaller, and they are rounded above. Small pali exist still further externally, and belong to higher orders; but two small rounded pali, belonging to the penultimate orders, are between the first and second rows. The septa are granulated in linear rows, which crowd the sides in regular vertical order.

There is a pellicular epitheca, which is stout, and the costæ are usually visible through it. It and the base are marked with concentric growth-rings, and on the innermost beyond the short, flat peduncle, the bases of the pali are more or less visible. The edge of the corallum is rounded; but where the costæ start from the septa there is often a sharp rim. The septal ends close to the costæ are subequal; but the costæ, where visible, are large and small, according to their order.

Height of the coral $\frac{1}{4}$ to $\frac{2}{10}$ and $\frac{3}{20}$ inch; breadth $\frac{12}{10}$ to $\frac{9}{10}$ inch.

Locality. West of Bhágathoro Hill, in the Nari series. Survey-number G $\frac{226}{76}$.

Illustrations of the Species in Plate XX.

Fig. 1. The corallum from above: natural size.
2. Septa and pali: magnified.
3. The corallum from below: natural size.
4. The central part of the base: magnified.

TROCHOCYATHUS NUMMIFORMIS, *Duncan*. Variety 1. Plate XX, Fig. 5.

In this variety the crown of larger pali consists of those of the first four cycles, those before the higher orders being stouter than those before the tertiaries, but shorter than those of the primaries and secondaries. The septa are largely granular, and the epitheca is dense, the coral being very flat.

Locality. West of Bhágathoro Hill, south of Sehwán, Nari series. Survey-number G $\frac{226}{76}$.

Illustration of Var. 1 *in* Plate XX.

Fig. 5. The inner crown of pali: magnified.

TROCHOCYATHUS NUMMMIFORIS, *Duncan*. Variety 2. Plate XX, Fig. 6.

In this variety the flat papillary columella is well seen, and the septa and pali are slenderer and often wavy.

Illustration of Var. 2 *in* Plate XX.

Fig. 6. The columella and inner part of the coral: magnified.

3. TROCHOCYATHUS NARIENSIS, *Duncan*. Plate IX, Figs. 1–13.

The corallum has a flat base, with banded epitheca in circles, and granular costæ are seen here and there. The corallum, according to its age, is discoidal, subcylindrical, and cylindrical and tall, and the sides are covered more or less with a banded epitheca, costæ appearing in the vacant spots. The calice is rarely larger than the base, and is often contracted and concentric in outline; it may be deep or shallow. There is no columella in the discoidal shaped forms, and a trabecular one exists in the others.

The septa are very numerous, and crowded near the margins; there are nearly, if not quite, six cycles of them. The larger are exsert, arched at the margin, straight, and end in a thin paliform lobe, which reaches the axial space; the three septa between each pair of these reach far inwards, are smaller than the others, and the two outer bend in and meet the middle one close to its end, a broad palus resulting. The pali are upon the septa where they join. The rest of the septa of this system are long and slender, and one is placed between each pair of those last mentioned. The calice is thus made up of a number of sets of eight septa. The sides of the septa are largely and distinctly granular. The costæ are large, unequal, largely granular in a single row on the outside, and granular and multigranular on the sides. The single row of granules becomes very distinct between the epithecal bands.

The breadth of the base of several specimens is from $\frac{9}{10}$ to 1 inch and $1\frac{2}{10}$ inch, and the height is from $\frac{2}{10}$ inch, $\frac{7}{10}$ inch, to 2 inches.

Locality. Near Raduk, ten miles S.S.E. of Jhángára, Nari series. Survey-number G $\frac{302}{74}$.

Illustrations of the Species in Plate IX.

Fig. 1. An oblique view of the corallum: natural size.
2. The septa and pali of part of a system: magnified.
3. A transverse section of a large specimen: slightly magnified.
4. The septa, magnified, oblique view.
5. The costæ and epitheca: natural size.
6. Costæ: magnified.
7. Costæ at the margin: magnified.
8. The base: natural size.
9. The costæ and epitheca of a large specimen: slightly magnified.
10. Side view of a tall and old specimen: natural size.
11. Its base.
12. A variety of the species: natural size.
13. Its septa and pali: magnified.

TROCHOCYATHUS NARIENSIS, *Duncan*. Variety. Plate XVI, Figs. 9, 10.

A variety of this polymorphic species requires notice, as the junction of the septa and the presence of the pali within it are not always seen. The large or primary septa of the five cycles have no pali; the next have them, and so have the next to them in size. A columella is visible.

Locality. Near Raduk, Nari group. Survey-number G $\frac{302}{74}$.

Illustrations of the Variety in Plate XVI.

Fig. 9. The calice: magnified.
10. Septa and pali: magnified.

4. TROCHOCYATHUS CYCLOLITOIDES, *Milne Edwards & Jules Haime, Hist. Nat. des Corall.* vol. ii. p. 36. Plate IX, Figs. 14–18.

There is a rather conical-shaped corallum of this widely distributed Eocene coral in the Nari series, west of Bhágathoro Hill, south of Sehwán. It has a widely open calice, whose surface is flat, with a small axial space. The epitheca is pretty strong, and the costæ are more or less distinct to the base. The pali are very evident. Faint exothecal dissepiments exist between the costæ near the base. The costæ are plain, and where coming from beneath the epitheca look like repetitions of septa.

Height of specimen $\frac{6}{10}$ inch; breadth nearly $1\frac{3}{10}$ inch.

Illustrations of the Species in Plate IX.

Fig. 14. The coral: side view.
15. The calicular surface.
16. The pali: magnified.
17. Costæ: magnified.
18. Costæ from beneath a ridge of epitheca: magnified.

BLANFORDIA, *gen. nov.*

The genus *Blanfordia*, now founded in recognition of the distinguished oriental naturalist and geologist to whom science is so greatly indebted in relation to the stratigraphy of Sind, is one of the Trochocyathaceæ. There is a pellicular epitheca binding the costæ to the discoid base, and the calice is cyclolitoid in shape, the axial space is elliptical, and the whole corallum is nearly circular.

The septa are numerous, close, and there are small pali on all the septa except those of the last order; and there is a very general and frequent union of two septa with an intermediate one, giving a Deltocyathine appearance.

1. BLANFORDIA NUMMIFORMIS, *Duncan*. Plate XVIII, Figs. 7–9.

The corallum is nummiform, with a flat base, the centre of which has partly enveloped a nummulite. The epitheca is marked with irregular lines. The calice is open, the axial space shallow, and the columella is deep and small. The septa are close crowded, long, slightly broader externally, and the fifth cycle is incomplete; the union of the three septa takes place very regularly on both sides of a long primary. The pali are small.

Height of specimen $\frac{1}{12}$ inch; breadth $\frac{3}{10}$ inch.

Locality. West of Bhágathoro Hill, south of Sehwán, Nari group. Survey-number G $^{228}/_{76}$.

Illustrations of the Species in Plate XVIII.

Fig. 7. The coral from above: magnified.
8. The base: magnified.
9. Septa: magnified.

Transition-Group STYLOPHORINÆ.

Genus STYLOPHORA, *M. Ed. & J. H.*

1. STYLOPHORA PULCHERRIMA, *D'Achiardi*. Plate XV, Figs. 12, 13.

A portion of a flat branch of this Coral, which is very common at Friuli (Rosazzo and Brazzano), where it is associated with *Stylophora distans*, Leymerie, is in the collection from the Nari group.

Locality. Rois Hill, east side, Nari group. Survey-number G $\frac{302}{80}$.

Illustrations of the Species in Plate XV.

Fig. 12. Surface of the corallum: slightly magnified.
13. Some calices: magnified.

Family ASTRÆIDÆ.

Subfamily EUSMILINÆ.

Genus TROCHOSMILIA, *M. Ed. & J. H.*

1. Trochosmilia varicosa, *Reuss.* Plate VIII, Fig. 11.

This species was described by A. E. Reuss in his description of the Corals found in one of the Coralliferous deposits of the Older Tertiaries of the Alps at Crosara. The Sind type is smaller than the European, but the shape is the same. The base is small and pedunculate, the body is irregularly cylindrical, constricted here and there, and the calices elliptical, shallow, and without a columella. The epitheca is distinct, and exists in some places as circular bands. The costæ are distinct, well developed, and correspond with the septa.

The species is described and figured in 'Pal. Stud. über die ält. Tertiärschichten der Alpen,' ii. Abtheilung, Wien, 1869, p. 22, plate xvii. figures 4–6.

Locality. Near Raduk, Nari series. Survey-number G $\frac{302}{74}$.

Illustration of the Species in Plate VIII.

Fig. 11. The corallum: natural size.

2. Trochosmilia Oldhami, *Duncan.* Plate III, Figs. 6–11.

The corallum is conical, much compressed, bluntly pedicellate, and often curved near the base. The calice is a long ellipse in shape, is shallow, and has rather a sharp edge.

The septa are very slender, crowded near the margin, and long and less crowded near the centre. There are four cycles of septa in nearly all the systems. The larger septa and the next in size reach to the centre, a small axial space existing; they are barely exsert, faintly arched, largely granular at the sides, and often slightly wavy. The next septa, in point of size, reach midway, and between them and the larger on either side there are usually three very small septa. There is no columella; and the endotheca is scanty.

The costæ are unequal in size, and correspond to the septa, so that there are in many places three minute costæ in a group, with a larger one on one side and a medium-sized on the other. The middle of the three small costæ is usually the largest, and they are often wavy and subsinuous in their course. The larger calices are almost subcrestiform at the ends of the coral, and may project a little here and there.

The exotheca exists; and a faint pellicular epitheca, with occasional growth-rings, may be seen in some specimens.

The epitheca covers in the smaller costæ in large specimens; they show, however, by weathering.

In full-grown specimens the calice is long, sinuous at the edge, broad, shallow, and on an even plane. The axial space is very small. Height of corallum $\frac{8}{10}$ inch. Length of calice $1\frac{3}{10}$; breadth $\frac{7}{10}$ inch.

Height of the coral $\frac{3}{10}$ inch.

Length of calice $\frac{6}{10}$ inch.

Locality. West of Bhágathoro Hill, south of Sehwán, Nari group. Survey-number G $\frac{236}{76}$.

Illustrations of the Species in Plate III.

Figs. 6, 7, 10. Views of the coral (2 specimens).
8, 9, 11. The arrangement of the septa.
See Plate IV, Figs. 11, 12, 13.

3. Trochosmilia Dharanensis, *Duncan.* Plate XIII, Fig. 11.

The corallum is cylindroid, tall, compressed rather from side to side, curved, and with a broadish base and a not much broader calice. The calice is elliptical in outline, rather contracted, and has 60 septa in six very irregular cycles. The septa are small, not very unequal, slender within, long, and the larger have subequal costæ. The costæ project, are distant, well developed, and wavy. The exotheca is seen here and there, and some folds of epitheca.

The base spreads rapidly from a small peduncle.

Height of corallum $2\frac{1}{2}$ inches.

Length of calice $1\frac{1}{10}$ inch.

Locality. South-west of Dharan Pass, Nari group. Survey-number G $\frac{302}{72}$.

The specimen has many of the usual Nari Nummulites on it.

Illustration of the Species in Plate XIII.

Fig. 11. The corallum: natural size.

Subfamily STYLINACEÆ.

Genus STYLOCŒNIA, *M. Ed. & J. H.*

1. Stylocœnia Taurinensis, *M. Edw. & J. Haime.* Plate XIII, Figs. 13, 14.

This common species is represented in the Nari series of Sind in strata west of Bhágathoro Hill, south of Sehwán. One specimen is in the form of a rounded but irregular mass, with an opening inferiorly, which seems to hint that the form has incrusted something. Another is a fractured specimen, which was part of a thick and compressed mass. They are both rather worn, and the projections at the angles of the calices are small and very indistinct in the second form, and quite rudimentary or wanting in the first. The calices are, as usual, small, tolerably close, separated by small and variable amounts of cœnenchyma, and contain six thin and slender primary septa; they reach a very slender, styliform columella. There are six smaller or secondary septa.

There are two calices and the intercalicular surface in $\frac{1}{10}$ inch.

Locality. West of Bhágathoro Hill, south of Schwán, Nari group (Survey-number G $\frac{226}{76}$), and near Raduk (Survey-number G $\frac{302}{74}$).

Illustrations of the Species in Plate XIII.

Fig. 13. The corallum.
14. Some calices: magnified.

The species has been found in the older Tertiary deposits of S. Giovanni Ilarione and Ronca, Castel Gomberto, Montecchio Maggiore, and in the Miocene of Turin, Rivalba, and Sassello.

Subfamily *ASTRÆACEÆ.*

Genus MONTLIVALTIA, *Lamouroux.*

1. MONTLIVALTIA VIGNEI, *D'Archiac & Haime.* Plate V, Figs. 9–11.

This species was described in the work on 'Les Animaux Fossiles de l'Inde' by D'Archiac and Haime, and the side view of the type was figured by them.

The species is found in the Nari series, south-west of Dharan Pass; and the specimen figured in Plate V shows the side view, with epitheca, costæ, and exotheca, and also a semidiagrammatic view of the calice, and a careful enlargement of some septa. The distinguished authors above mentioned had not the opportunity of seeing a calice, but they judged correctly that there would be five cycles of septa.

I find that there is a false columella, and that the characteristic of the species is the very constant junction of smaller and larger septa nearer the axial space than the margin.

Locality. South-west of Dharan Pass, Nari group. Survey-number of the specimen G $\frac{302}{72}$.

Illustrations of the Species in Plate V.

Fig. 9. Side view of the coral.
10. A calice: slightly magnified.
11. The junction of septa and the endotheca: slightly magnified.

Genus DASYPHYLLIA, *M. Ed. & J. H.*

1. DASYPHYLLIA GEMMANS, *Duncan, Ann. & Mag. Nat. Hist.* 1864, vol. xiii. p. 299, pl. xviii. Plate XIII, Fig. 10.

A solitary broken corallite of this species shows the incipient "collarettes" low down, the costæ well developed, and the calice, as usual, compressed and badly preserved.

The type is in the British Museum.

Locality. Near Raduk, 10 miles south-east of Jhángára, in the Nari group. Survey-number G $\frac{302}{74}$.

Illustration of the Species in Plate XIII.

Fig. 10. The corallite: natural size.

Genus RHABDOPHYLLIA, *M. Ed. & J. H.*

1. Rhabdophyllia Nariensis, *Duncan.* Plate XVIII, Figs. 14–16.

The corallum is short, slender, cylindroid, compressed, and marked with transverse growth-rings.

The epitheca is delicate, and where worn exposes three very thin costæ between two larger ones. The fractured ends show twelve large septa with swollen internal edges, and twelve more slender ones; and usually between these and the thicker a minute septum exists.

The septa are crowded, and correspond to similar sized costæ. There is no columella. The endotheca is scanty.

Height of corallum 1 inch; greatest breadth $\frac{3}{10}$ inch.

Locality. West of Bhágathoro Hill, south of Sehwán, in the Nari group. Survey-number G $\frac{226}{76}$.

Illustrations of the Species in Plate XVIII.

Fig. 14. The corallum: natural size.
15. Transverse section: magnified.
16. Costæ: magnified.

Genus LEPTORIA, *M. Ed. & J. H.*

1. Leptoria concentrica, *Duncan.* Plate XXIII, Figs. 1, 2.

This species is found at the base of the Nari series, or in the topmost strata of the Khirthar rocks; but the type is from a higher horizon in the Gáj series.

Genus MÆANDRINA, *M. Ed. & J. H.*

1. Mæandrina Medlicotti, *Duncan.* Plate X, Figs. 15, 16.

The corallum is large, broad, short, somewhat convex above, and rather concave below, where there is an epitheca.

The series are excessively gyrose and frequently bifurcate, and are almost without any limit; they are shallow and narrow, very equal in their breadth, and the interserial edge is sharp.

The septa are short, enlarged within, and mostly are subequal. Occasionally a small septum intervenes, but usually the similarity of size is remarkable.

The columella is rudimentary.

There are about twenty septa in $\frac{5}{10}$ inch.

Breadth of the corallum more than 5 inches; height of corallum 1 inch.
Breath of a series $\frac{2}{10}$ inch.
Locality. Baran River, south of Tong, in the Nari series. Survey-number G $\frac{226}{65}$.

Illustrations of the Species in Plate X.

Fig. 15. Part of the corallum: natural size.
16. Part of a series: magnified.

Genus PRIONASTRÆA, *M. Ed. & J. H.*

1. PRIONASTRÆA INSIGNIS, *Duncan.* Plate V, Figs. 4–6.

The corallum is free, short, hemispherical, and has a flat, irregularly rounded, and lobed base, and a few large calices.

The base is marked with numerous subequal low costæ, more or less hidden by a feeble epitheca.

The calices near the base look outwards, and the others more or less upwards; they are irregular in size and shape, but are large, deep, open, triangular or hexangular, and are separated by stout and tall margins.

The septa are much more numerous on the sides of the tall margins than in the midst of the calices; they are small and close in the first place, and large, separate, and mostly club-ended in the other. There are altogether nearly five cycles in the largest calice, but only some twenty septa reach the boundary of the axial space. The club end represents the base of a former spine, and the septa having it are large and dip down into the fossa, being, moreover, separated at the wall by small ones. The columella is small, and is partly made up of the united club ends.

The margin of the calices is rather sharp and crestiform. Tho gemmation is marginal and between contiguous calices.

The breadth of the base is 1½ inch, and the height of the corallum $\frac{1}{10}$ inch. The calices vary from $\frac{2}{10}$ to $\frac{5}{10}$ inch in length, and the greatest depth of the fossa is $\frac{2}{10}$ inch.
Locality. South-west of Dharan Pass, Nari group. Survey-number G $\frac{202}{72}$.

Illustrations of the Species in Plate V.

Fig. 4. Upper part of the corallum: natural size.
5. The calices near the margin: magnified.
6. The base: natural size.

2. PRIONASTRÆA TENUISEPTATA, *Duncan.* Plate V, Figs. 1–3.

The corallum is irregularly quadrangular at the base, the corners being rounded more or less. A small scar of former adhesion is in the middle of the basal surface, and small and rather close costæ radiate from it, increasing in number towards the edge, which is rather sharp. There is a slight opitheca here and there, and the basal surface is flat.

The calicular surface of the coral is but slightly convex, and the calices are large and irregularly shaped; they are shallow, open, and separated by very well-defined, low, thick walls. The septa are close but not crowded, often wavy, long and slender; and the primaries and secondaries are but slightly stouter than the others; a few have a slight enlargement near the small trabecular columella. There are four cycles of septa in the large calices.

Length of corallum $1\frac{1}{2}$ inch; height of corallum $\frac{1}{2}$ inch.

Length of largest calice $\frac{8}{10}$ inch.

Locality. West of Bhágathoro Hill, south of Sehwán, Nari group. Survey-number G $\frac{236}{76}$.

Illustrations of the Species in Plate V.

Fig. 1. Calices: slightly magnified.
2. The base: natural size.
3. A part of a calice: magnified.

Family FUNGIDÆ.

Genus CYCLOSERIS, *M. Ed. & J. H.*

1. Cycloseris Perezi, *M. Ed. & Haime.* Plate XVI, Figs. 7, 8.

This well-known Eocene form appears to be represented in the Nari group in the hills east of Trak in Kohistan. Survey-number G $\frac{280}{52}$.

It is a broken specimen, but the calice is shallow and was circular. The fossula is circular and small; the base is subplane, and the costæ are generally visible, a small quantity of epitheca existing. The principal difference from the type is the everted calicular edge. The European type is from Nice; Gap; Faudon, St. Bonnet (Hautes-Alpes).

Illustrations of the Species in Plate XVI.

Fig. 7. The calice: natural size.
8. Showing the everted margin and costæ: magnified.

Genus CYCLOLITES, *Lamarck.*

1. Cyclolites orientalis, *Duncan.* Plate IX, Figs. 19–21.

The corallum is circular in outline, nearly flat above, rounded off at the margin, and very slightly concave centrally inferiorly, elsewhere nearly flat. The axial space is circular and small.

The septa are very closely placed, crowded, slender, straight, swollen at the free end so as to imitate pali, and united by delicate synapticulæ. The 12 principal septa are evident and project outwards, and there are 24 others less prominent, and the 48 intermediate are smaller still. There are six cycles of septa complete.

The epitheca is dense, but the larger costæ project beneath it.

The breadth of the corallum is nearly five times the height of it; and in the type the measurements are, breadth $\frac{9}{10}$ inch and height not quite $\frac{2}{10}$ inch.

Locality. Lundi Hill, eight miles south of Jhángára, Nari group. Survey-number G $\frac{302}{73}$.

Illustrations of the Species in Plate IX.

Fig. 19. The calicular surface: slightly magnified.
20. The septa and their paliform ends: magnified.
21. Septa near the margin: magnified.

Specimens of larger size than the type and with slight peduncles are from hills east of Trak, Kohistan, Nari group. Survey-number G $\frac{302}{52}$.

Group MADREPORARIA PERFORATA.

Family PORITIDÆ.

Genus LITHARÆA, *M. Ed. & J. H.*

1. **Litharæa nodulosa**, *Duncan*. Plate XIX, Figs. 4, 5.

The corallum is in the shape of short stunted branches, which are covered with irregularly quadrangular shallow calices with thick perforate walls. The shape and size of the calices is irregular, and the septal distribution also, there being from 20 to 30 stoutish septa. There is a small or rudimentary columella in some calices, whilst it is long in others. The calices are crowded.

Height of corallum 2 inches.

Breadth of calices $\frac{1}{10}$ to $\frac{2}{10}$ inch.

Locality. Near Raduk, ten miles S.E. of Jhángára, Nari series. Survey-number G $\frac{302}{74}$.

Illustrations of the Species in Plate XIX.

Fig. 4. The coral: natural size.
5. A calice: magnified.

List of the Species of Fossil Corals which are found in the Nari Series of Sind, and which are identical with those found in other localities.

Trochocyathus cyclolitoides, M. Ed. & J. Haime. Also in the Nummulitic deposits of the Pyrenees and S. Giov. Ilarione. Rosazzo in Friuli.

Stylophora pulcherrima, D'Achiardi. Common at Rosazzo in Friuli.

Trochosmilia varicosa, Reuss. In the Oligocene of Crosara.

Stylocœnia Taurinensis, M. Ed. & J. H. At Ronca, S. Giov. Ilarione, and in the Miocene of Turin, Rivalba, &c.

Cycloseris Perezi, M. Ed. & J. H. Gap; Nice; Faudon, St. Bonnet (Hautes-Alpes).

There are 20 species of Fossil Corals in the Nari series, and one of them is found at a higher horizon. Of these, one quarter are found in the Upper Nummulitic and Oligocene deposits of Europe.

Hence the examination of the specimens of Corals from the Ranikot, Khirthar, and Nari series of Sind yields 76 species and several varieties.

X. *Description of the Fossil Corals from the Gáj Group in Sind.*

List of Species of Madreporaria from the Gáj group or the series above the Nummulitic rocks of Sind.

Section **MADREPORARIA.**

Group MADREPORARIA APOROSA.

Family TURBINOLIDÆ.

Subfamily CARYOPHYLLIACEÆ.

Caryophyllia Gajensis, *Duncan.*

Subfamily TROCHOCYATHACEÆ.

Trochocyathus Gajensis, *Duncan.*

Transition-group STYLOPHORINÆ.

Stylophora confusa, *Duncan.*

Stylophora minuta, variety, *Duncan.*

Family ASTRÆIDÆ.

Subfamily STYLINACEÆ.

Stephanocœnia maxima, *Duncan.*

Subfamily ASTRÆACEÆ.

Antillia plana, *Duncan.*
——— Indica, *Duncan.*
Montlivaltia Jacquemonti, *J. Haime.*
Dasyphyllia, species.
Leptomussa rugosa, *Duncan.*
Calamophyllia elongata, *Duncan.*
Leptoria concentrica, *Duncan.*
Monticulastræa insignis, *Duncan.*
——————— solidior, *Duncan.*
——————— inæqualis, *Duncan.*
——————— elongata, *Duncan.*
Heliastræa Sindiana, *Duncan.*
————— digitata, *Duncan.*
————— anomala, *Duncan.*

Brachyphyllia Indica, *Duncan.*
Plesiastræa costata, *Duncan.*
————— decipiens, *Duncan.*
————— pedunculata, *Duncan.*
D'Achiardia densa, *Duncan.*
————— lobata, *Duncan.*
Latimæandra parvula, *Duncan.*
————— Reussi, *Duncan.*
————— Gajensis, *Duncan.*
Prionastræa Gajensis, *Duncan.*
————— fungiformis, *Duncan.*
Cladocora Haimei, *Duncan.*
Echinopora miocenica, *Duncan.*
————— maxima, *Duncan.*

Family FUNGIDÆ.

Pachyseris affinis, *Duncan.*
————— exarata, *Duncan.*

Cycloseris magnifica, *Duncan.*
Agaricia Danæ, *Duncan.*

Group MADREPORARIA PERFORATA.

Subfamily MADREPORINÆ.

Madrepora, species.

Subfamily TURBINARINÆ.

Turbinaria Sitaensis, *Duncan*.

Astræopora hemisphærica, *Duncan*.

Family PORITIDÆ.

Porites Gajensis, *Duncan*.

Section **MADREPORARIA.**

Group MADREPORARIA APOROSA.

Family TURBINOLIDÆ.

Subfamily CARYOPHYLLIACEÆ.

Genus CARYOPHYLLIA, *Lamarck*.

1. CARYOPHYLLIA GAJENSIS, *Duncan*. Plate XXIV, Figs. 2, 3.

The corallum is short, with a large base of attachment and a large circular, very open, shallow calice. The pali form a very distinct raised ring around a very small columella, on which a few papillæ may be seen. The septa are unequal in size, much thickest near the margin, and the primaries and secondaries resemble each other, pass far inwards and have pali before them; the next orders are not so large, and the higher orders pass but a short distance inwards. There are about 72 septa, and about 20 shorter stout dentate pali. The costæ are well developed, are alternately large and small, and the epitheca is in bands.

Height of the corallum $\frac{4}{10}$ inch. Breadth of calice $\frac{9}{10}$ inch. Breadth of base $\frac{6}{10}$ inch.

Locality. Sita Nai, Gáj series. Survey-number G $\frac{298}{3}$.

Illustrations of the Species in Plate XXIV.

Fig. 2. The corallum: side view.
3. The calice: magnified.

Subfamily TROCHOCYATHACEÆ.

Genus TROCHOCYATHUS, *M. Ed. & J. H.*

1. TROCHOCYATHUS GAJENSIS, *Duncan*. Plate XXIII, Figs. 3, 4.

The corallum has a flat elliptical base, from which the sides slope with concave curves to a widely open, oval-elliptical, slightly bilobate calice, whose minor axis is on a higher plane than the major. The costæ are numerous, irregularly arranged, subequal and distinct to the base. The large septa are about 48 in number, and many minute rudimentary ones exist. The larger septa are stout, and the pali are small but distinct, those before the larger septa being the largest.

Locality. Sita Nai, Khirthar range, Gáj series. Survey-number G $\frac{298}{3}$.

Illustrations of the Species in Plate XXIII.

Fig. 3. Side view: natural size.
4. The base and costæ: magnified.

Transition-group STYLOPHORINÆ.

Genus STYLOPHORA, *Blainville.*

1. Stylophora confusa, *Duncan.* Plate XXIII, Fig. 7.

The corallum is nodular here and there, and the calices are very close and crowded, a small ridge formed by the close margin separating them; the margins are fused in some places; and the calicular fossa is rather deep. There are six septa visible, and a small columella. There are three calices and their intermediate ridges in $\frac{1}{10}$ inch of length.

Locality. Dumb, Sehwán-hill road, Gáj series. Survey-number G $\frac{326}{10}$.

Illustration of the Species in Plate XXIII.

Fig. 7. Calices: magnified.

2. Stylophora minuta, *Duncan*, variety. Plate XXIII, Fig. 6.

This species was described by me in the description of the Fossil Corals of the West-Indian Islands (part iv.), 'Quarterly Journal of the Geological Society,' December 1867 (vol. xxiv. p. 14). The type unfortunately broke up; but the small calices, the broad interspace without ornamentation, the six septa, and the large styloid columella were very characteristic. The present specimen, from Naigh-Nai valley, south-west of Manchhar Lake, resembles the type, especially in the plain and faintly granular cœnenchymal area, in the plain projection of the calicular margin, and in the want of costæ. The columella is small, however, and this constitutes the only variation. The type was from Miocene beds of Trinidad.

Survey-number G $\frac{302}{40}$.

Illustration of the Species in Plate XXIII.

Fig. 6. Calices: magnified.

Family ASTRÆIDÆ.

Subfamily STYLINACEÆ.

Genus STEPHANOCŒNIA, *M. Ed. & J. H.*

1. Stephanocœnia maxima, *Duncan.* Plate XXV, Figs. 1, 2.

The corallum is thick, large, and massive, and the base is almost a flat surface. The calices are large, slightly raised above the common surface, with a thin costulate and rather wavy margin; they are slightly elliptical in outline, very shallow, and are crowded with very unequal septa. The calices are separated by cœnenchyma, over which the larger costæ pass, touching those of the surrounding calices, which are usually at a distance of half a calice's breadth from each other.

There are six large septa, which are straight, level, usually larger near the columella, and normally have pali which are expanded sideways or are nodular. The primaries are separated by as many smaller secondaries, which are stout, and enlarge and expand near the columella into small pali; the twelve interseptal spaces thus produced include very small septa, usually one in each, but occasionally three are crammed in. These tertiary septa are small, and do not reach far inwards. The columella is well developed and styloid, but rectangular and compressed in shape. In some calices the twelve larger septa are united at their internal margins by lateral expansions.

The costæ are unequal in size, being attached at the margin to all the septa, and it is only those of the primaries and secondaries that reach the intercalicular space.

The corallites are very long; endotheca is rare; and the free inner margins of the septa are denticulate.

Height of corallum $3\frac{3}{4}$ inches; length probably some feet. Length of largest calice rather more than $\frac{1}{16}$ inch.

Great masses of this coral exist with the septa and columella worn away, or in the form of casts.

Locality. Dumb, Schwán-hill road, Gáj group. Survey-number G $\frac{226}{16}$.

Illustrations of the Species in Plate XXV.

Fig. 1. A calice: magnified.
2. Part of a calice seen from the side: magnified.

Subfamily ASTRÆACEÆ.

Genus ANTILLIA, *Duncan.*

1. ANTILLIA PLANA, *Duncan.* Plate XXIII, Fig. 5.

This species was described in 1864, in my essay on some Fossil Corals from Sind, in the 'Annals and Magazine of Natural History' (1864, vol. xiii. p. 300, pl. xviii. fig. 5). A specimen has been found at Dumb, Schwán-hill road (Survey-number G $\frac{226}{16}$), in the Gáj series. The new form is of the same size as that already described, but the outline of the calice is circular.

The corallum is very short, and has a flat base which nearly equals the calice in diameter; the columellary space is small and the calice is shallow. The septa are numerous, and there are at least five cycles of them; they crowd near the margin, and only the larger reach far inwards. Epitheca is noticed here and there, and the costæ are moniliform externally.

Breadth of calice $1\frac{1}{2}$ inch. Height of the coral $\frac{1}{2}$ inch.

Illustration of the Species in Plate XXIII.

Fig. 5. The corallum: natural size.

2. ANTILLIA INDICA, *Duncan.* Plate XXIV, Fig. 11.

The corallum is tall and conical, is elliptical at the widely open calice, and the columella is small. The septa are very unequal. The epitheca is in transverse folds, and it comes well up to the calicular margin. There are nearly six cycles of septa, and the majority reach far in towards the axial space. The larger septa appear to have been lobed within and ragged on their free surface near the calicular margin.

Height nearly 3 inches.

Length of the calice $2\frac{3}{16}$ inches.

Locality. North-west of Lál-Bakhar range near Karáchi, in the Gáj series. Survey-number G $\frac{302}{47}$.

Illustration of the Species in Plate XXIV.

Fig. 11. The corallum and calice: natural size.

Genus MONTLIVALTIA, *M. Ed. & J. H.*

1. MONTLIVALTIA JACQUEMONTI, *D'Archiac & Haime.* Plate XXIV, Fig. 4.

The corallum is straight, conical, thick, moderately tall, compressed slightly, especially in its middle. The epitheca is strong and forms growth-rings. The calice is elliptical, more or less in the form of the figure 8. The axes of the calice have the ratio of 100 : 170; the summit of the smaller axis is slightly higher than that of the larger. There are 120 well-developed septa, moderately slender, straight, alternately large and small, and between them is a corresponding number of rudimentary septa. The height of the corallum may be more than 2 inches. The endotheca is well developed.

Messrs. D'Archiac and J. Haime do not give the locality whence the coral was derived, but state that it is peculiar to Sind.

The specimen found by the Geological Survey is in height $2\frac{2}{16}$ inches, and the breadth of the calice is $1\frac{4}{16}$ inch.

Locality. Dumb, Schwán-hill road, in the Gáj series. Survey-number G $\frac{226}{16}$.

Illustration of the Species in Plate XXIV.

Fig. 4. The corallum: natural size.

Genus DASYPHYLLIA, *M. Ed. & J. H.*

1. DASYPHYLLIA, species. Plate XXIII, Fig. 10.

A portion of a small *Dasyphyllia* allied to *Dasyphyllia gemmans*, Duncan, is from south of Magar Pir, Karáchi, Gáj series. Survey-number G $\frac{302}{51}$.

Illustration of the Species in Plate XXIII.

Fig. 10. Part of a corallum: natural size.

Genus LEPTOMUSSA, *Reuss.*

1. LEPTOMUSSA RUGOSA, *Duncan.* Plate XXII, Fig. 8.

The corallum is simple, tall, compressed, very irregular in its growth, being constricted here and there above its broad pedunculate base. The calice is elongate, deformed, rather deep, and without a columella. The costæ are exceedingly developed, and in many places are spined; they are distant, projecting, and subequal. There is no epitheca, but some exotheca exists between the costæ. The septa are unequal, numerous, and crowded; the primaries are large, and the higher orders are long, slender, and wavy, and relate to the larger costæ.

The genus has its type, *Leptomussa variabilis*, D'Achiardi, in the Nummulitic of Italy. The form from Sind approaches a true *Mussa* which has not yet undergone fissiparity; but it is an old individual and fully developed.

Height of corallum $2\frac{1}{3}$ inches.

Length of calice $1\frac{3}{4}$ inch.

Locality. South of Magar Pir, near Karáchi, Gáj series. Survey-number G $\frac{302}{51}$.

Illustration of the Species in Plate XXII.

Fig. 8. The corallum: natural size.

Genus CALAMOPHYLLIA, *M. Ed. & J. H., amended* 1831.

1. Calamophyllia elongata, *Duncan.* Plate XVIII, Figs. 17–20.

The corallum is in long, more or less cylindrical pieces which seldom branch, and then from one side. The corallites are of the same slender character for considerable spaces; they are smallest at the base or point of origin from others, and frequently the calice is contracted; they are nearly straight, cylindrical or angular here and there, and are marked with very distinct rather distant costæ, some of which are much larger than others. From 24 to 36 costæ exist in large specimens, and are wavy, sharp, narrow, and much smaller than the intercostal space, in which there is often a low rounded ill-developed costa. As a rule, the costæ correspond to large septa only.

The septa, few in number, are wide apart, and are alternately large and small; they are tapering, and do not quite reach the axial space. Some are rudimentary and curve close to the wall. There are 36 to 40 septa of all sizes in a well-developed specimen.

There is no columella, and the axial space is vacant. A few endothecal dissepiments exist. There is no epitheca, and there are traces of a few exothecal dissepiments. A few irregular swellings of the thin wall occur as collarettes.

Height of longest corallite 4 inches. Breadth of widest corallite $\frac{1}{2}$ inch.

Locality. Nari Nai, Khirthar range, Gáj series. Survey-number G $\frac{298}{6}$.

Illustrations of the Species in Plate XVIII.

Fig. 17. Corallite: natural size. *a.* A long corallite.
18. Outlines of calices: natural size.
19. A section of a corallite: magnified.
20. Costæ: magnified.

Genus LEPTORIA, *M. Ed. & J. H.*

1. **Leptoria concentrica**, *Duncan.* Plate XXIII, Figs. 1, 2.

The corallum is large, flat, circular in outline, broadly pedunculate, thin at the edges, and rather concave centrally above.

The series are very long, and many form almost perfect circles one within the other, so that the surface presents the appearance of a number of furrows and ridges arranged in irregular concentric circles.

The ridges are sharp and equal, the valleys are broad and deep, and each of the series is uninterrupted by calices. The columella is very small, but it is clearly lamellar. The septa are small, alternately larger and smaller, the first kind reach to the axis of the valley and enlarge there, the smaller come down to it more or less. Buds of an *Hydnophora* have settled themselves in some of the series.

The peduncle is short and broad; the base is marked concentrically by a ridge; and there appears to have been an epitheca.

Height of the coral $1\frac{1}{2}$ inch; breadth originally 8 inches.

Length of series 10 inches, $8\frac{1}{2}$ inches, to about 3 inches; breadth about $\frac{3}{10}$ inch.

Locality. Dumbar range, south-west of Tong, Gáj series (Survey-number G $\frac{302}{56}$); also at Maliri, south of Chotra, in the Khirthar or Nari series (Survey-number G $\frac{302}{92}$).

Illustrations of the Species in Plate XXIII.

Fig. 1. The corallum: natural size.
2. Some septa: magnified.

MONTICULASTRÆA, *gen. nov.*

The corallum is massive or foliated, pedunculate, irregular at its upper surface, an the base is covered with crowded radiating costæ. The septa are in very irregular small series, so that each colline is small and either pointed or very short, and hence the series often present a papillary appearance. The septa are small, numerous, do not touch those of the other side of the axial space, and are united by a highly developed endotheca. There is a columella which is continuous around the collines; it is lamellar, but convex above, and is readily worn away.

This genus is a *Hydnophora* with a columella and with non-continuous septa.

1. **Monticulastræa insignis**, *Duncan.* Plate XXVI, Figs. 1-3.

The corallum is very large, thick in some parts, and thin at the edges. The small close collines are very numerous, very irregular in their size, not in any regular lines, and are short. The colline edge is short. The septa, alternately long and short and large and small, are slender and close; probably three cycles of them exist around the largest colline.

The columella is well developed. The costæ are exceedingly numerous.

Height of the corallum $2\frac{1}{2}$ inches; breadth about 14 inches.

There are about 6 or 8 collines to an inch. Height of collines under $\frac{2}{10}$ inch.

Locality. Magar Pir, near Karáchi, base of Gáj group. Survey-number G $\frac{304}{8}$.

Illustrations of the Species in Plate XXVI.

Fig. 1. Part of the corallum.
2. Collines: magnified.
3. Endotheca and columella: magnified.

2. **Monticulastræa solidior**, *Duncan.* Plate XXVI, Figs. 5, 6.

The corallum is large, very thick, and nearly plane on its upper surface. The collines are stout, low, unequal, and often curved; and the septa are alternately large and small, but are of equal length. The tip of the collines is blunt, rounded, and sometimes notched. The columella is thin and linear.

Height of the corallum 3 inches.

Length of collines $\frac{1}{10}$ to $\frac{7}{10}$ inch. Six septa to $\frac{1}{10}$ inch.

Locality. Sita Nai, Khirthar range, Gáj group. Survey-number G $\frac{228}{3}$.

Illustrations of the Species in Plate XXVI.

Fig. 5. Part of the upper portion of the coral: natural size.
6. A colline: magnified.

3. **Monticulastræa inæqualis**, *Duncan.* Plate XXVI, Fig. 4.

The corallum is solid, thick, and the upper and lower surfaces are flat. The collines are very irregular in their size, shape, direction, and length: some are long, broad, straight, or curved; others are minute, low, and at all angles with the larger. The columella is distinct, and the septa (alternately large and very slender and small) are of equal length.

Height of corallum 1 inch to $1\frac{1}{2}$ inch.

Length of large collines $1\frac{1}{10}$ inch; of small collines $\frac{1}{10}$ to $\frac{2}{10}$ inch. Number of septa to $\frac{1}{10}$ inch, six large and six small.

Locality. Near Unahar, Khirthar range, Gáj group. Survey-number G $\frac{228}{4}$.

Illustration of the Species in Plate XXVI.

Fig. 4. Upper part of the corallum (part of): natural size.

4. **Monticulastræa elongata**, *Duncan.* Plate XXVII, Figs. 1, 2.

The corallum is very large, in flat branches, which are covered on all sides with very numerous, small, yet elongated narrow series, their diminutive height and length contrasting with the bulk of the mass. The direction and size of the series are very variable, and small collines are occasionally seen in the axial spaces of others. The collines are blunt at the top and never high; the valleys are narrow; and the columella is distinct as a lamellar ridge in the axial space; it is low and distinct (but it often has been destroyed). The septa do not unite at the axial space; they are frequently swollen there, and always are alternately large and small and rather crowded, and there are about 16 to $\frac{1}{10}$ inch.

The length of the collines is from less than a line to 1 inch, and the distance from the top of one to that of its neighbour is under $\frac{3}{10}$ inch.

Length of the coral (a broken specimen) 10 inches, and the breadth is about 4 inches; thickness $1\frac{1}{2}$ inch.

Locality. South-east of Bill, Gáj series. Survey-number G $\frac{202}{43}$.

Illustrations of the Species in Plate XXVII.

Fig. 1. Part of the corallum: natural size.
2. Collines: magnified.

Genus HELIASTRÆA, *M. Ed. & J. H.*

1. Heliastræa Sindiana, *Duncan.* Plate XXVII, Figs. 3, 4.

The corallum is short and broad, irregular on its nearly plane upper surface, thin at the more or less circular margin, and indistinctly pedunculate. The base expands rapidly; and is covered with a dense epitheca, on which costæ are not seen. The calices, unequal in size, are circular or slightly deformed in outline; the margin is sharp; the septa are not exsert, but pass down into the deep fossa; and the costæ are feebly developed, and do not pass down far on the outside, and not much on the intercalicular spaces. The normal number of septa is four cycles; they are alternately long and short; all are rather small, and the longer are often furnished with paliform teeth. In the smaller calices there may be 24 or 36 septa; but the alternate large and small septa are characteristic. The columella is moderately well developed.

Height of corallum $1\frac{3}{4}$ inch; breadth 5 to 6 inches.

Breadth of calices $\frac{3}{4}$ to $\frac{4}{10}$ inch.

Locality. Magar Pir, near Karáchi, base of Gáj series. Survey-number G $\frac{204}{8}$.

Illustrations of the Species in Plate XXVII.

Fig. 3. The corallum (a part of): natural size.
4. Some calices: magnified.

2. Heliastræa digitata, *Duncan.* Plate XXI, Figs. 7, 8.

The corallum is compressed, digitate, and covered with numerous crateriform calices, the intermediate tissue being covered with costæ.

The truncated conical ends of the corallites are either symmetrical or oblique, and the costæ are alternately large and small: the larger costæ pass down the wall to the intercorallite spaces. The calice is very shallow, and the columella very small. The septa are very unequal: usually the six primaries are large and distinct, and the six secondaries are smaller than they are, but larger than the short tertiaries. There are often only twelve septa. The calice is often contracted, and the costæ are larger than the septa.

Height of corallum $3\frac{1}{2}$ inches; breadth 1 inch.

There are about six corallites and intermediate structure to the length of 1 inch.

Locality. South-east of Bill, Gáj series. Survey-number G $\frac{302}{43}$.

Illustrations of the Species in Plate XXI.

Fig. 7. The corallum: natural size.

8. Calices: magnified.

3. Heliastræa anomala, *Duncan.* Plate XXI, Fig. 10.

The corallum is very short, covers a wide extent of surface, is nearly flat above, and, although pedunculate, has almost a flat base covered with radiating longitudinal folds of epitheca.

The calices project but slightly, are irregular in shape and separate, and costæ pass down into the intercorallite spaces. The calices are shallow, oblique, circular, or deformed or elliptical; and the columella is very small. The septa at the margin are very thick, and within the fossa are distinct, narrow, as a rule wide apart, unequal, and in four cycles; usually some of the primaries are very distinct and long. Dissepiments are rare. The corallum is many inches long and about 1 inch thick.

The diameter of the calice is from $\frac{3}{10}$ to $\frac{9}{10}$ inch.

Locality. South-east of Bill, Gáj series. Survey-number G $\frac{302}{43}$.

Illustration of the Species in Plate XXI.

Fig. 10. Some calices: natural size.

Genus BRACHYPHYLLIA, *Reuss.*

1. Brachyphyllia Indica, *Duncan.* Plate XXI, Fig. 2.

The corallum is massive, convex above, circular in outline, and flat below. The corallites are large, united by exotheca, and the costæ of neighbouring calices often unite. The calices are circular, oval, elliptical, and irregular in outline, shallow, and crowded with septa, which pass so far upwards that there is barely a columella. The septa are in five cycles in six systems in the largest calices, and are alternately large and very small; and this is the case with the costæ also. The exotheca is well developed. The distances of the calices differ; some are wide apart and others are crowded.

Height of corallum 2 inches; breadth 7 inches.

Length of calices $\frac{2}{3}$ to 1 inch.

Locality. Dumb, Sehwán-hill road, Gáj group. Survey-number G $\frac{226}{16}$.

Illustration of the Species in Plate XXI.

Fig. 2. A portion of the corallum: natural size.

Genus PLESIASTRÆA, *M. Ed. & J. H.*

1. PLESIASTRÆA COSTATA, *Duncan.* Plate XXIV, Figs. 9, 10.

The corallum is massive, nearly flat above, and short. Numerous corallites project, some obliquely from the common surface over which the costæ pass, and most are in cones, widely truncated and crateriform, whilst a few are oval or elliptical in their calicular outline. The calices, usually circular in outline, are not deep, and the well-marked costæ merge into thick and exsert septa at the margin. The septa, not crowded, are alternately large and very small, are thick at the wall, and the larger become thinner as they plunge with an arched edge into the fossa, to end in blunt nodular-shaped, compressed pali: there are four cycles in the largest calices, and the pali are before all except the last, whose septa barely project within the wall. The columella is large and strongly papillary. The costæ are thicker than the septa, cover the outside of the wall, are stout, wide apart, and have rounded projections on them; The smaller are in contact with the smaller septa.

Diameter of calice $\frac{1}{4}$ inch.

Height above common surface $\frac{3}{10}$ inch.

Locality. Naigh Nai, south-west of Sehwán, Gáj series. Survey-number G $\frac{302}{40}$.

Illustrations of the Species in Plate XXIV.

Fig. 9. A portion of the coral: natural size.
10. A calice: magnified.

2. PLESIASTRÆA DECIPIENS, *Duncan.* Plate XXI, Figs. 3, 4.

The corallum is very large, massive, and slightly gibbous on its upper surface. The corallites are more or less raised above the common surface and have well-marked costæ. The corallites are united by much exotheca, and the bluntly but distinctly spined costæ pass over it. The calices, usually circular, vary greatly in size; the larger project, and have a very shallow fossa and the costæ well marked around the margin, whilst the smaller, equally complete, often barely project.

The columellary space is circular and distinct, and the columella has small papillæ on it. The septa vary much in number; but the larger are subequal, and a minute one is between them. According to the size of the calice, there may be 9, 10, 12, to 16 large septa, and as many rudimentary ones. The costæ are well developed, stand out, and are bluntly spiny, especially near the intercalicular surface. Small but very distinct elongations of the large septa exist, resembling pali.

The budding is extracalicular and on the common exothecal surface. The pali are small and before the long septa.

Height of specimen 2 inches.

Diameter of the calices: largest, $\frac{1}{4}$ inch; smaller, $\frac{1}{10}$ inch.

Locality. Sita Nai, Gáj series. Survey-number G $\frac{298}{3}$.

Illustrations of the Species in Plate XXI.

Fig. 3. Part of the corallum: natural size.
4. Calices: magnified.

3. **Plesiastræa pedunculata**, *Duncan*. Plate XXI, Fig. 9.

The corallum is short, large, circular in outline, slightly irregularly convex or plane above, pedunculate, and with an epitheca in longitudinal folds, the costæ being slightly visible. The calices are large, very irregular in size and shape, not standing up much above the common surface on which their costæ pass, shallow, and with large septa and very small pali. The septa in the largest calices are nearly equal; but usually a small septum is between the large, so as to make four cycles or more. The costæ are large, bluntly spined, and a rudimentary one is often between two larger.

Height of corallum $1\frac{3}{4}$ inch; breadth 5 inches.

Breadth of calice $\frac{3}{10}$ to $\frac{5}{10}$ inch.

Locality. South-east of Bill, Gáj series. Survey-number G $\frac{302}{43}$.

Illustration of the Species in Plate XXI.

Fig. 9. Some calices: magnified.

D'ACHIARDIA, *gen. nov.*

The corallum is massive. The corallites are small, slightly exsert above the thick, solid, common upper exothecal intercorallite cœnenchyma, or are imbedded, as it were, in it; they are long and slightly costulate. The calices are shallow, and there is a columella, and some pali are also seen. Fissiparity occurs, but is rare.

1. **D'Achiardia densa**, *Duncan*. Plate XXI, Figs. 5, 6.

The corallum is large, irregularly cylindrical, and roundedly conical above. It is covered with numerous calices, most of which are shallow and circular, and separated by more or less granular surface.

There are three cycles of septa, which are alternately long and short, pali being usually before the larger.

The columella is small. The costæ are distinct on the flanks of the corallite, but not on the cœnenchyma. The cœnenchyma is very solid.

Height of the corallum 5 inches.

Breadth of the base nearly $2\frac{1}{2}$ inches.

Breadth of a calice $\frac{3}{20}$ inch.

Locality. Nari Nai, Khirthar range, Gáj series. Survey-number G $\frac{298}{6}$.

Illustrations of the Species in Plate XXI.

Fig. 5. The corallum: natural size.
6. Calices: magnified.

2. D'ACHIARDIA LOBATA, *Duncan*. Plate XXI, Figs. 4, 5.

The corallum springs from a small, narrow, compressed base, and rises into a flat, lobate, rounded, gibbous frond, which is covered with calices, more or less oblique in direction, sometimes deformed and separated by much cœnenchyma. The costæ are rudimentary. The columella is rather large and flat, and minutely papillose. The septa, usually 24 in number, alternately large and small, often have pali. The calicular margins are slightly above the level of the common cœnenchyma, which is minutely lamellar or granulate.

Height of corallum 3 inches; length $3\frac{1}{2}$ inches; breadth about $\frac{3}{4}$ inch.

Diameter of calices $\frac{1}{13}$ to $\frac{1}{10}$ inch.

Locality. South-east of Bill, Gáj series. Survey-number G $\frac{302}{43}$.

Illustrations of the Species in Plate XXI.

Fig. 4. The upper surface of the corallum: natural size.
5. A calice: magnified.

Genus LATIMÆANDRA, *D'Orb.*

1. LATIMÆANDRA PARVULA, *Duncan*. Plate XXII, Figs. 1, 1*.

The corallum is large, thin, much foliated, and is gibbons above, and more or less costate and epithecate below, where there are sometimes long grooves and eminences corresponding with lines of calices above.

The calices are small, excessively variable in size, and the series, which are rare, are usually narrow and short. The margins are sharp; the fossa is usually deep; and the septa are of two kinds: one set is very small and close to the margin, and the other, wide apart, have strong, often curved and arched laminæ. The septa are few in number, and there are not more than 30 in full-sized non-serial calices. The columellary space is very small. The septa often meet in points above the margin. The walls are stout, and the endotheca is well developed and arched.

Height of specimen $\frac{1}{2}$ inch.

Width of average calices six to $\frac{5}{10}$ inch.

Length of average series $\frac{2}{10}$ inch to $\frac{1}{4}$ inch.

Locality. Magar Pir, near Karáchi, base of Gáj group. Survey-number G $\frac{324}{8}$.

Illustrations of the Species in Plate XXII.

Fig. 1. Calices: magnified.
1*. A part of the corallum: natural size.

2. LATIMÆANDRA REUSSI, *Duncan*. Plate XXV, Fig. 5.

The corallum is large, short, unequally convex and gibbous above, and pedunculate and concave below. It is rather thin here and there and at the edges. A delicate pellicular epitheca covers the distant subequal costæ on the base.

The calices are excessively variable in shape within any given space: some are pentangular, others are hexagonal in outline, and the rest form longer or shorter series, some being straight and others curved. The fossa is moderately deep, the columella is rudimentary, and the walls are thin, but united. The equality in thickness and in relative distance of the septa is very striking; they are slender, usually straight and subequal, and there are three cycles, and not a perfect fourth, in the non-serial calices.

Height of corallum 2 inches; breadth 6 to 10 inches.

Breadth of ordinary calices $\frac{2}{10}$ to $\frac{5}{10}$ inch.

Length of series about $\frac{6}{10}$ inch.

Locality. South-east of Bill, Gáj series. Survey-number G $\frac{302}{43}$.

This species is closely allied to *Latimæandra limitata*, Reuss, from the Upper Nummulitic of Italy; and I name it after my lamented friend.

Illustration of the Species in Plate XXV.

Fig. 5. A part of the corallum: natural size.

3. LATIMÆANDRA GAJENSIS, *Duncan*. Plate XXV, Figs. 3, 4.

The corallum is large, pedunculate, nearly flat inferiorly, circular more or less in outline and thin at the edges, and irregular and gibbous on the upper part. There is an epitheca on which the costæ are visible here and there, and they are subequal, distinct, branching, and slightly granular. The calices are mostly in short and deformed, rather than in straight series; they are deep, and are separated by a stout wall. The septa are very small, crowded, especially at the wall, not exsert, and a few become enlarged near the axial space, where no columella is visible. In some regularly shaped calices, which have not become serial, there are nearly five cycles of septa. The epitheca in some places is in longitudinal or radial projections.

Height (extreme) 1½ inch; length 6 inches.

Locality. Magar Pir, at the base of the Gáj group near Karáchi. Survey-number G $\frac{304}{8}$.

Illustrations of the Species in Plate XXV.

Fig. 3. Calices: natural size.
4. Calices: magnified.

Genus PRIONASTRÆA, *M. Ed. & J. H.*

1. PRIONASTRÆA GAJENSIS, *Duncan*. Plate XXII, Fig. 3.

The corallum is large, massive, broadly pedunculate, broad and rather convex above, circular in outline, and the rapidly expanding base has longitudinal eminences and depressions. The calicular surface has a few (18 in the type) large, deep, somewhat irregularly shaped calices, which are united by stout, well-developed walls, which project irregularly. The columella is small. The septa are long, distinct, do not project much, subequal, spined, and numerous, and, as a rule, there are more than four cycles and less than five of them.

The epitheca is distinct, and barely a trace of costæ exists. The endotheca is very well developed.

Height of corallum nearly 2 inches.

Breadth of upper surface 4 inches.

Length of calices about 1 inch.

Locality. South of Magar Pir, near Karáchi, Gáj series. Survey-number G $\frac{302}{51}$.

Illustration of the Species in Plate XXII.

Fig. 3. The corallum: natural size.

Probably *Cyathoseris magnifica*, Duncan, "Sind Corals," Ann. & Mag. Nat. Hist. 1864, xiii. p. 304, is this species, the presumed synapticulæ being the worn dissepiments; but I am not satisfied on the point.

2. PRIONASTRÆA FUNGIFORMIS, *Duncan.* Plate XXI, Fig. 1.

The corallum is large, low, circular in outline, very slightly convex above, thin at the edge and pedunculate, and slightly concave beneath. There is a slight epitheca, but usually the costæ and exotheca are visible.

The calices, rarely circular, are polygonal, irregular in size and shape, and have wide united walls, the septa being continuous. The fossa is shallow and open; the columella is trabecular and well developed. The septa are wide apart, nearly equal, and some reach further in than others. The septal number presents much variation; but in the largest calices there are not more than 28, and usually there are about 24. The gemmation is marginal.

Height of specimen 1 inch; breadth 7 inches.

Length of largest calice $\frac{6}{10}$ inch.

Locality. Near Unahar, Khirthar range, Gáj series. Survey-number G $\frac{298}{4}$.

Illustration of the Species in Plate XXI.

Fig. 1. A portion of the upper surface: natural size.

Genus CLADOCORA, *M. Ed. & J. H.*

1. CLADOCORA HAIMEI, *Duncan.* Plate XXIII, Figs. 8, 9.

This species was described from Sind by me in the 'Annals & Magazine of Natural History,' April 1864. The corallites are long and slightly flexuous; the buds are few; the calice is usually circular, but often deformed. The septa are small and delicate, and the larger are smaller than their costæ; there are three cycles of them, more or less complete. The columella and pali are small. The costæ are alternately large and small, and some are much produced.

Calices $\frac{3}{10}$ to $\frac{4}{10}$ inch across.

Locality. South of Magar Pir, near Karáchi, Gáj series. Survey-number G $\frac{302}{51}$.

Illustrations of the Species in Plate XXIII.

Fig. 8. Side view of pieces of a corallum.
9. Calice: magnified.

Genus ECHINOPORA, *Lamarck.*

1. Echinopora miocenica, *Duncan.* Plate XXII, Fig. 2.

The corallum is frondiform, lamellar, and covering much space, but it is rather thin.

The calices are well separated, and form distinct projections somewhat in regular transverse lines; they are large, shallow, rather elliptical, and the columella is very small. The septa are short, rather equal, and may be from 12 to 24 or more in number, and they are spined. The costæ are long, straight as a rule, separated, spined, and are continuous with the septa of neighbouring calices, especially with those not close at the sides of the others. The endotheca beneath the costæ is highly developed. The epitheca exists, and there are faint striations on it.

Length of a calice $\frac{3}{10}$ inch, and its costal prolongations to others, including the calice, $1\frac{1}{2}$ inch.

Locality. South-east of Bill, Gáj series. Survey-number G $\frac{302}{43}$.

Illustration of the Species in Plate XXII.

Fig. 2. The upper surface of a worn corallum: natural size.

2. Echinopora maxima, *Duncan.* Plate XX, Fig. 7.

The calices are very large, elevated, elliptical, and shallow. The septa are crowded' large, subequal, and in three cycles. The columella is indistinct, but exists. The costæ, very large, are bluntly spined and hollow here and there; they are flexuous and subequal. The epitheca is thick and faintly striated.

Breadth of the calice $\frac{6}{10}$ inch; length of the calice 1 inch; height of the calice $\frac{4}{10}$ inch.

Locality. South of Magar Pir, near Karáchi, Gáj series. Survey-number G $\frac{302}{51}$.

Illustration of the Species in Plate XX.

Fig. 7. The calice: natural size.

Family FUNGIDÆ.

Genus PACHYSERIS, *M. Ed. & J. H.*

1. Pachyseris affinis, *Duncan.* Plate XXIV, Figs. 7, 8.

The corallum is thin, and has formed part of a large, irregular, gibbous expansion. The series are very long, broad, and only slightly curving here and there from the straight course; the valleys are broader than the intervening collines, which are broadly convex, slightly flat at the top, and passed over by crowded septa. The columella is rudimentary. The septa, alternately large and small, are long, and the larger reach furthest to the columellary line. The base is marked by fine costal striations, and the synapticulæ are rare everywhere.

The breadth of a colline at its base is considerable, and from $\frac{2}{10}$ to $\frac{3}{10}$ inch. About from 7 to 10 septa in $\frac{1}{10}$ inch.

Locality. Maki Nai, in the Gáj series. Survey-number G $\frac{226}{45}$.

Illustrations of the Species in Plate XXIV.

Fig. 7. A part of the corallum: natural size.
8. A part: magnified.

2. Pachyseris exarata, *Duncan.* Plate XXIV, Figs. 5, 6.

The corallum is very large, flat above and below, and the series are excessively long, nearly straight, and rarely bifurcate. The valleys are wide, shallow, and unequal; and the collines are low, slightly oblique, broad at the base, and rounded where free. The septa are close, crowded, narrow, and subequal on the collines, which they cross; but near the columella they become unequal and alternately large and small. The larger septa reach the columella, expand parallel with it, and join it by means of delicate trabeculæ. The smaller septa become slender near the columella, and may or may not reach it. In some parts smaller septa reach from the collines a little way into the valley, and are placed between those already noticed. The columella is distinct, has a lamellar tip which is not continuous, and in some places it is out of the axial line. The synapticulæ are rare.

The length of some series is considerably more than 6 inches; some restricted series are from $\frac{1}{2}$ inch to 1 inch in length, and the majority are nearly parallel, slightly wavy, and very long. The width of the valleys from the top of one colline to that of the other is from $\frac{1}{4}$ inch to nearly $\frac{1}{2}$ inch. The bases of the collines are from $\frac{2}{10}$ to $\frac{3}{10}$ inch across.

Locality. South of the Gáj river, in the Khirthar range, in the Gáj series. Survey-number G $\frac{298}{2}$.

Illustrations of the Species in Plate XXIV.

Fig. 5. The corallum: natural size.
6. A portion: magnified.

Genus CYCLOSERIS, *M. Ed. & J. Haime.*

1. Cycloseris magnifica, *Duncan, Ann. & Mag. Nat. Hist.* 1864, xiii. p. 304. Plate XXVI, Fig. 13.

The corallum is large, convex, irregularly rounded above, and trochoid, with a small attachment below; the wall is in longitudinal folds, which do not interfere with the calicular surface, and it is very faintly costulated. The calicular surface is very Heliastræan in its appearance. The calices are irregular in shape, and unequal in size and depth, all being more or less open at the surface, and infundibuliform; they are separated by a cœnenchyma, which is more or less marked by costæ. The septa are numerous at the margin, and are grouped in paliform masses in contact with the broad, flat, paliform columella.

Height of corallum $2\frac{1}{10}$ inches; breadth 3 inches and more.

Breadth of a calice from $\frac{4}{10}$ to $\frac{7}{10}$ inch or more.

Locality. Magar Pir, near Karáchi, base of Gáj series. Survey-number G $\frac{284}{8}$.

The specimen is attached to the type of *Haliastræa Sindiana*, Duncan, and is not in good condition. The type is in the British Museum, and the calice represented is from the drawing in the 'Annals and Magazine of Natural History,' 1864, pl. xix. fig. 7, *b*.

Illustration of the Species in Plate XXVI.

Fig. 13. A calice: slightly magnified.

Genus AGARICIA, *Lamarck*.

The species *Agaricia agaricites*, Pallas, sp., I have stated to be present in a collection of fossil Corals from Sind already described. Another form is closely allied to *Agaricia undata*, Ellis and Solander, but has a few distinctive characters.

1. Agaricia Danæ, *Duncan*. Plate XX, Figs. 8, 9.

The corallum is pedunculate, frondiform, and rises sharply in more or less of a cup-shape. The wall is thin, and the outer surface slightly marked with cross depressions and raised ridges, and is mostly striated with unequal costæ. The inner surface is covered with numerous calices, which run together often at the sides, but are separated by costæ and small collines from their neighbours below and above. The calices are about $\frac{3}{20}$ inch in length; their septa are alternately large and very small, and so are the costæ, and usually they are less than 20 in number. The columella is very small.

Height of specimen rather over 2 inches, and the whole was probably about 6 inches in height. The thickness is from $\frac{1}{10}$ to nearly $\frac{3}{10}$ inch.

Locality. South of Magar Pir, near Karáchi, Gáj series. Survey-number G $\frac{202}{51}$.

This species is very closely allied to the *Mycedium fragilis* of Dana.

Illustrations of the Species in Plate XX.

Fig. 8. Calices: magnified.
9. The back and base of the corallum: natural size.

Group MADREPORARIA PERFORATA.

Subfamily MADREPORINÆ.

Genus MADREPORA, *M. Ed. & J. H.*

Madrepora, species. Plate XXV, Fig. 9.

Several rolled specimens of the minute terminal branchlets of a small oblique caliced Madrepora were found at Naigh-Nai valley, Gáj series. Survey-number G $\frac{302}{40}$.

Illustration of the Species in Plate XXV.

Fig. 9. A branchlet: natural size.

Subfamily TURBINARINÆ.

Genus TURBINARIA, *Oken.*

1. Turbinaria Sitaensis, *Duncan.* Plate XXV, Figs. 7, 8.

The corallum is thin, foliaceous, and marked by irregular vermiform costæ inferiorly. The cœnenchyma is plentiful; the calices, on short, obliquely placed cones, are small, shallow, and round. The columella is very small, and there are 24 unequal septa.

Thickness of the corallum $\frac{2}{10}$ to $\frac{3}{10}$ inch.

Breadth of a calice $\frac{1}{10}$ inch. Length of the cones $\frac{2}{10}$ inch.

Locality. Sita Nai, Khirthar range, Gáj series. Survey-number G $\frac{226}{43}$.

Illustrations of the Species in Plate XXV.

Fig. 7. The corallum (part of): natural size.
8. A portion: magnified.

Genus ASTRÆOPORA, *Blainville.*

1. Astræopora hemisphærica, *Duncan.* Plate XXV, Fig. 6.

The corallum is irregularly hemispherical in shape, with a re-entering base, covered with epitheca, and marked here and there with granulations or pores. The upper surface, rather gibbous, has much cœnenchyma; and the calices, some on conical eminences, others simple, are small, circular, very shallow, and have six large and about six small septa. There is no columella. The cœnenchyma is granular and porous.

Height of the corallum 1½ inch; breadth 2½ inches.

Locality. Naigh-Nai valley, Gáj series. Survey-number G $\frac{302}{40}$.

Illustration of the Species in Plate XXV.

Fig. 6. The corallum: natural size.

Family PORITIDÆ.

Genus PORITES, *Lamarck.*

1. Porites Gajensis, *Duncan.* Plate XXII, Figs. 6, 7.

The corallum is massive, has a broad base, and an irregular cylindrical stem ending in several gibbous pinnacles which are rounded at the top. Layers of growth are on the corallum, which is covered with minute calices well separated by a porous cœnenchyma. The septa are 12 in number; the pali are very small, and the columella also.

Height of the corallum nearly 3 inches; breadth 2 inches.

There are five calices and intermediate structure in $\frac{4}{10}$ inch.

Locality. Naigh-Nai valley, Gáj series. Survey-number G $\frac{302}{40}$.

Illustrations of the Species in Plate XXII.

Fig. 6. The corallum: natural size.
7. A calice: magnified.

There are 41 species of fossil Corals from the Gáj series.

The forms belong both to ancient and modern genera, and the fauna does not contain any recent species. The absence of so many of the modern genera of the Pacific and Red Sea, considered with the evident antiquity of many of the genera, indicates a Miocene age. Many of the forms are representative of the West-Indian Miocene.

Many massive specimens of Corals form a limestone which is saccharoid, and the septa usually are very incomplete; they usually belong to the great species of *Stephanocœnia*.

XI. *List of the Localities whence Fossil Corals were derived in Sind.*

In the Strata below the Trap (Cretaceous).

Barki nala, north of Ranikot—Laki range.
Jakhmari—Laki range.
Bárah—Laki range.

In the Ranikot Group, Nummulitic Series.

Three miles west of Lynyan.
Hills east of Lynyan.
Three miles south-west of Jhirk (Jerruck).
Jhirk.
Jhirk—from lowest fossiliferous bed.
Hills two or three miles north-east of Band Vero.
North-west of Lynyan.
Hilly ground north-by-east of Petiáni.
East of Kandaira, Vero plain.
Ditto, a lower bed.
Vihan hill, six miles north-east of Kandaira, Vero plain.
South-west of Jhirk.
Makli hill, near Thatta.

In the Khirthar Series, Upper Nummulitic Series.

Angai valley south-west of Tandra Ráhim Khán.
Two miles south-south-west of Chotra, south of Jhángára.
Karra range, south of Trak.
North of Maliri and sixteen miles south of Jhángára.

Gagar nala, north-east of Bula Khan's Thana.
Gagar hill, east of Surjána.
South-east of Trak.
West of Sehwán (from conglomerates of Siwalik age).
Tandra Ráhim Khán (from recent conglomerate).
North-west of Mehar (from recent conglomerate).
Nari Nai (from gravels).
Gáj river.
Near Maiting, twelve miles south-south-east of Ranikot.
Near Petiáni, west of Kotri.
Jakhmari, west of Amri.
East base of Khirthar range between Gáj and Nari rivers—from uppermost beds.
Northern end of Watwáro range between Trak and Damáj (base of Nari or top of Khirthar).
Mál Mohori, Rampitiani river, west of Jungsháhi (base of Nari or top of Khirthar).
Between Tong and Baili, west of Tong (base of Nari or top of Khirthar).
Maliri, south of Chotra (base of Nari or top of Khirthar).
Hindi hill, north of Trak (uppermost Khirthar beds).

In the Nari Series, Oligocene Series.

Baran river, south of Tong.
West of Bhágathoro Hill, south of Sehwán.
Pokhan.
West side of Bhágathoro Hill.
Under Khóguzáni Peak—Laki range.
Hills east of Trak—Kohistan.
South-west of Dharan pass.
Lundi hill, eight miles south of Jhángára.
Near Raduk, ten miles south-south-east of Jhángára.
East side of Rois hill, south-east of Damáj.
Rois hill, east side.

In the Gáj Group, Miocene.

Magar Pir, near Karáchi (base of group).
Three miles south-east of Tong.
Dumbar range, south-west of Tong.
Mol plateau, ten miles north of Sháhbeg.
Near Magar Pir (higher bed).
South of Magar Pir, near Karáchi.
Naigh Nai, south-west of Sehwán.

Kattiáni hills, north of Gaggar.
Base of scarp four miles west of Trak hill.
Maki Nai.
Lál-Bakhar range, twelve miles west-north-west of Karáchi.
North of Babba-band, five miles east of Kadeji.
Amru hill, Khirthar range.
South of Kubá Jágu Jumáli, west-north-west of Schwán.
Dumb, Schwán-hill road.
South of Gáj river, Khirthar range.
Sita Nai (Tooneewarree Nai), Khirthar range.
Near Unahar, Khirthar range.
Nari Nai, Khirthar range.
Tandra Ráhim Khán.
Base of scarp four miles west of Trak.
Three miles south-west of Damáj.
Near Bill.
Hills north of Adam-jo-got.
Five miles south-south-east of Tong.
Mol plateau, north-west of Bill.
Naigh-Nai valley, south-west of Manchhar Lake.
South-east of Bill.
North-west of Lál-Bakhar range near Karáchi.
(Marine beds in lower Manchhar) eight miles east of Cape Monze*.

XII. *List of the Genera of the Fossil Corals of Sind, their Enumeration and that of the Species.*

Genera from the Cretaceous Strata beneath the Trap.

MADREPORARIA APOROSA.

	Species.
1. Caryophyllia	3
2. Trochocyathus	1
3. Smilotrochus	2
4. Stylophora	1
5. Rhabdophyllia	1

MADREPORARIA PERFORATA.

6. Litharæa	1 & 1 variety.
6 genera.	Species 9 & 1 variety.

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* Unfortunately the corals from this locality could not be found in the collection.

Genera from the Ranikot Series.

MADREPORARIA APOROSA.

	Species.
1. Trochocyathus	1
2. Placocyathus	1
3. Blagrovia	1
4. Trochosmilia	1
5. Stylina	1
6. Stylocœnia	3
7. Montlivaltia	3
8. Feddenia	3 & 2 vars.
9. Plocophyllia	2
10. Diploria	1
11. Leptoria	1
12. Stephanocœnia	1
13. Astrocœnia	5 & 1 var.
14. Isastræa	1
15. Reussastræa	1
16. Pironastræa	1
17. Astræa	1

Fam. FUNGIDÆ.

18. Thamnastræa	1
19. Pachyseris	1
20. Trochoseris	1
21. Elliptoseris	1
22. Cyathoseris	1
23. Turbinoseris	5
24. Cyclolites	9

MADREPORARIA PERFORATA.

25. Stephanophyllia	1
26. Litharæa	1
27. Porites	1
27 genera.	Species 50 & 3 vars.

Genera from the Khirthar Series.

MADREPORARIA APOROSA.

	Species.
1. Trochocyathus	1
2. Leptocyathus	1
3. Stylophora	1
4. Stylina	1
5. Montlivaltia	1
6. Calamophyllia	1
7. Hydnophora	1
8. Favia	2
9. Astrocœnia	1
10. Isastræa	1
11. Latimæandra	1
12. Pterastræa	1
13. Plesiastræa	1

MADREPORARIA PERFORATA.

14. Porites	2
14 genera.	16

Genera from the Nari Series.

MADREPORARIA APOROSA.

	Species.
1. Trochocyathus	4 & 3 vars.
2. Blanfordia	1
3. Stylophora	1
4. Trochosmilia	3
5. Stylocœnia	1
6. Montlivaltia	1
7. Dasyphyllia	1
8. Rhabdophyllia	1
9. Leptoria	1
10. Mæandrina	1
11. Prionastræa	2

Fam. FUNGIDÆ.

12. Cycloseris	1
13. Cyclolites	1

MADREPORARIA PERFORATA.

14. Litharæa	1
14 genera.	20 & 3 vars.

Genera from the Gáj Series.

	Species.
MADREPORARIA APOROSA.	
1. Caryophyllia	1
2. Trochocyathus	1
3. Stylophora	2
4. Stephanocœnia	1
5. Antillia	2
6. Montlivaltia	1
7. Leptomussa	1
8. Dasyphyllia	1
9. Calamophyllia	1
10. Leptoria	1
11. Monticulastræa	4
12. Heliastræa	3
13. D'Achiardia	2
14. Prionastræa	2
15. Brachyphyllia	1
16. Plesiastræa	3
17. Latimæandra	3
18. Cladocora	1
19. Echinopora	2
Fam. FUNGIDÆ.	
20. Pachyseris	2
21. Cycloseris	1
22. Agaricia	1
MADREPORARIA PERFORATA.	
23. Madrepora	1
24. Turbinaria	1
25. Astræopora	1
26. Porites	1
26 genera.	41

Summary.

Number of genera in the Cretaceous series	6
„ species „ „	9
Number of genera in the Ranikot series	27
„ species „ „	50
Number of genera in the Khirthar series	14
„ species „ „	16
Number of genera in the Nari series	14
„ species „ „	20
Number of genera in the Gáj series	26
„ species „ „	41
Species common to more than one series	1

The result of comparison of the species of the Cretaceous series with those of other localities shows them to belong to an horizon which is not represented in Europe, and that they probably belong to passage-beds between the Secondary and Tertiary formations.

The Ranikot series appear to be of the age of the Nummulitic of Europe, and the Khirthar also.

The Nari series appear to be of Oligocene age.

The Gáj series are Miocene, and not of an early part of the formation.

XIII. *Results of an Examination of the Species which have been described by D'Archiac and Jules Haime and myself in former years.*

It will be observed, in examining the lists of the species of fossil Corals described in this Monograph, that several of those which were noticed by MM. d'Archiac and J. Haime in their celebrated work on the 'Animaux Fossiles de l'Inde,' and some of those which were considered in my essay on the Fossil Corals from Sind (1864), are not mentioned. This arises partly because the carefully made collection of the Geological Survey of India, from known localities, did not contain specimens of the forms, and partly because some of the species were described from or recognized by bad specimens.

MM. d'Archiac and J. Haime examined collections which came from all the geological horizons of Sind except that of the strata beneath the Trap; but the localities whence their types were derived were not recorded, except under the head of places which have no recognized geographical position, or where all the Tertiary strata are found. The term Hála Mountains is most deceptive and it has no geographical meaning; and it was from those hypothetical hills that most of the specimens so ably described by Jules Haime were derived.

I was equally unfortunate in my early essay with regard to stratigraphical and geographical knowledge.

Nevertheless it is necessary to reconsider the species not hitherto described in this Monograph, but which were found somewhere or other in Sind.

Notice of Species of Corals described by MM. d'Archiac and J. Haime, but which are not represented by Specimens in the Collection.

1. Trochocyathus Van-den-Heckei, *J. Haime.*

The corallum is slightly elongate, subpedicellate, compressed, and more or less bilobate. The base is more or less slightly arched in the plane of the smaller axis, and the growth-rings are feebly marked. The costæ are straight, delicate, subgranular, very slightly projecting, alternately slightly unequal, and most distinct near the calice, where they may be subcrestiform. There are 130 to 160 of them. The calice is usually in the shape of the figure "8." The septa are thin and slightly unequal. The height of the corallum is 3 centimetres (about 1$\frac{1}{10}$ inch), and the great axis of the calice is nearly 4 centimetres in length, or 1½ inch.

But J. Haime, whilst noticing the existence of this well-known form at La Palarea, near Nice, writes that he has never seen a specimen from France or Sind that presented the columella and pali sufficiently to diagnose the form satisfactorily.

If reference be made to the Plates accompanying this Monograph, several rather bilobate forms of simple corals will be observed; but none of them refer to a *Trochocyathus* of the description given above. In fact, it is not a good species; and any bilobate, costulate coral, with its calice filled up, may be called *Trochocyathus Van-den-Heckei*, and of course very unsatisfactorily.

2. CERATOTROCHUS EXARATUS, *M. Edw. & J. Haime.*

This large, simple coral is placed hypothetically by D'Archiac and J. Haime in Sind; and they had not the advantage of observing its calice. There is little doubt that it is a species of *Feddenia.*

3. TROCHOSMILIA CORNICULUM, *M. Edw. & J. Haime.*

This is not a good species; and the form which I have described as *Trochosmilia varicosa*, Reuss, is probably that taken for the above by the distinguished French authors.

There are some specimens of a simple coral which resemble in some points this species. They were found near Raduk in the Nari series. They have between four and five cycles of septa, visible costæ, epitheca in a slight degree, and a small columella. The species may be *Montlivaltia Vignei*, J. Haime, or it may be a young *Dasyphyllia.*

4. TROCHOSMILIA MULTISINUOSA, *J. Haime.*

This is a doubtful species, according to M. J. Haime, *op. cit.* p. 187.

There is a large bilobate coral in the collection from Jhirk in the Ranikot series, which has the aspect of this species as well as of *Trochocyathus Van-den-Heckei*; but it is a bilobate *Montlivaltia*, and is comparable to a great extent with *Montlivaltia bilobata*, Mich. sp., from the Nummulitic of Europe, at La Palarea.

5. STYLOCŒNIA EMARCIATA, *J. Haime.*

This form is represented in the Ranikot collection of Corals by a young *Stylocœnia maxima.* I do not think that the European form is found in Sind.

6. PHYLLOCŒNIA IRRADIANS, *M. Edw. & J. Haime.*

This species, which was not figured by D'Archiac and Haime, is not in the collection.

The specimens collected by the Geological Survey, and which, when not clean, would be said at the first glance to belong to the genus *Phyllocœnia*, are really furnished with pali and a papillose columella, and belong therefore to the genus *Plesiastræa.*

8. SIDERASTRÆA FUNESTA, *M. Edw. & J. Haime.*

This species has not been found. It was not figured by D'Archiac and J. Haime.

The critical examination of the species of fossil Corals described by me in the 'Annals and Magazine of Natural History,' 1864 (vol. xiii.), indicates that many of them were not found by the Geological Survey, and that a few only have a satisfactory locality given to them.

Thus *Oculina Halensis*, nobis, *Phyllocœnia conferta*, nobis, *Phyllocœnia Lucasana*, M. Ed. & H., *Astrocœnia Caillaudi*, M. Ed. & J. H., *Montlivaltia brevis*, nobis, *Antillia dentata*, nobis, *Antillia ponderosa*, M. Ed. & J. H., sp., *Cladocora Haimei*, nobis, *Hydnophora rudis*, nobis, *Hydnophora plana*, nobis, *Hydnophora hemisphærica*, nobis, *Trochoseris aperta*, nobis, *Cyathoseris Valmondoisiaca*, M. Ed. & J. H., *Pachyseris rugosa*, M. Ed. & J. H., *Agaricia agaricites*, M. Ed. & J. H., and *Porites incrustans*, M. Ed. & J. H., species clearly definable, and which were described and figured for the most part in the 'Annals and Magazine of Natural History,' April 1864, are without satisfactory geological horizons. They swell the list of the fossil Corals of the province; and it is to be hoped that, in years to come, they will be satisfactorily located in their proper stratigraphical position. They were derived from the neighbourhood of Karáchi, and doubtless came from the Gáj series. Some of them are figured on Plate XXVI. and Plate XXVII.

XIV. *A Description of the Fossil Alcyonaria from the Gáj Series of Sind.*

There are several specimens of Alcyonaria from the Gáj group of strata, the size of which indicates a very flourishing fauna; they are closely allied to those of the Italian, Sicilian, and Australian middle and later Tertiary deposits. Seguenza, in his 'Disquisizione Paleontologicha intorno ai Corallarii fossili della rocca Terziaria del distretto di Messina' (Torino, 1863), gives a summary of the fossil forms known to him and to previous observers, such as Goldfuss and Michelotti; and in 1875 the author of this Monograph published descriptions of fossil Alcyonaria from Australia and New Zealand in the 'Quarterly Journal of the Geological Society,' vol. xxxi.: in 1864 he had noticed the occurrence of *Corallium pallidum* in the Sind Tertiaries in the 'Annals and Magazine of Natural History' (April 1864).

List of the Species of Alcyonaria from the Gáj Series of Sind.

Family GORGONIDÆ, MM. Milne Edwards & Jules Haime, Hist. Nat. des Corall. vol. 1. p. 134.

Subfamily ISIDINÆ.

Genus ISIS, *Lamouroux, Hist. des. Polyp. corall. flex.* p. 468.

Isis Danæ, *Duncan*, and variety.
Isis elongata, *Duncan*.
Isis compressa, *Duncan*.
Isis, species 1, 2, 3.

ALCYONARIA.

Family GORGONIDÆ.

Subfamily ISIDINÆ.

Genus ISIS.

1. Isis Danæ, *Duncan*. Plate XXVIII, Figs. 1–3.

Fragments of a huge *Isis* abound in the collection from Naigh-Nai valley, south-west of Manchhar, and also in the Gáj series; and they appear to be characterized by very numerous flexuous grooves and corresponding ridges on their surface, and by numerous, alternately large and small, lamellæ passing into the midst of the sclerobasic axis. The ridges are moderately distinct, project slightly, and are often alternately large and small; they are most distinct in the smaller joints. The joints are irregularly cylindrical, long, stout, branch at the ends, and present the appearance here and there of abortive interjoints. The upper and lower surfaces, nearly circular in outline, are slightly concave or plane.

The great size of the joints distinguishes the form to a certain extent; they are much longer than broad, and it appears that the interjoints must have been small.

Length of joint $2\frac{1}{2}$ inches, $1\frac{7}{10}$ inch, and $1\frac{9}{10}$ inch; breadth $1\frac{2}{10}$ inch and $\frac{6}{10}$ inch.

Locality. Naigh-Nai valley, in the Gáj series (Survey-number G $\frac{302}{40}$), and five miles north-west of Tong, in the same series (Survey-number G $\frac{302}{19}$); and at Tandra Ráhim Khán (Survey-number G $\frac{302}{8}$).

Illustrations of the Species in Plate XXVIII.

Fig. 1. Large joint: natural size.
2. End of a joint, part of: magnified.

Isis Danæ, *Duncan*. Variety.

This form has many abortive branchlets or projections on opposite sides of the joints, along their length.

Locality. Naigh-Nai valley. Survey-number G $\frac{302}{40}$.

Illustration of the Variety in Plate XXVIII.

Fig. 3. Joints: natural size.

2. Isis elongata, *Duncan*. Plate XXVIII, figs. 6, 7.

The joints are long in relation to their breadth; the interjoints were very thin; the ridges are very distinct, and the fluting regular. The ridges are subequal, except when they bifurcate. The cylindrical reed-like joint is marked with the traces of aborted interjoints, and the ends of it are nearly flat.

Length of the joint $1\frac{8}{10}$ inch; breadth $\frac{4}{10}$ inch.

Locality. Naigh-Nai valley, south-west of Manchhar Lake. Survey-number G $\frac{302}{40}$.

Illustrations of the Species in Plate XXVIII.

Fig. 6. The joints: natural size.
7. A transverse section: magnified.

3. Isis compressa, *Duncan*. Plate XXVIII, Figs. 4, 5.

The joints coalesce laterally, and form a large irregular stem, which is compressed, the interjoints being frequent. The ridges and furrows are very irregular and almost reticulate in places, and the radial lamellæ are not numerous. The joining surfaces of the joints are elliptical in outline and nearly flat.

Height of stem $2\frac{8}{10}$ inches; thickness $\frac{7}{10}$ and $\frac{3}{10}$ inch.

Locality. Tandra Ráhim Khán, in the Gáj series. Survey-number G $\frac{298}{8}$.

Illustrations of the Species in Plate XXVIII.

Fig. 4. The mass: natural size.
5. The top of a joint: magnified.

Isis, sp. 1.

This is a species resembling somewhat *Isis corallina*, Morren, and some *Isidinæ* from the Coralline zone of Cape Otway, Australia, described by myself. It is impossible to give a specific name to the variable hard parts of every *Isis*.

The specimen under consideration is short, about as tall as broad, slightly compressed, very slightly constricted, and faintly projecting above and below. The ridges and furrows are very visible above and below and on the flanks. On the last-named part the flutings are broad and straight, and the ridges are well developed and straight. It separates into two above and below, and has the appearance of being notched at the edge of the upper and lower articulating surfaces. It is figured in Plate XXVIII. Figure 8 gives a side view, and Figure 9 a magnified view of the upper surface. The length is nearly $\frac{3}{10}$ inch.

An *Isis*, in part remarkably preserved, was found in the same stratum as that just noticed, and is closely allied, the only distinction being that the striæ are less marked and less numerous. The joints are broader than high, and the interjoint substance has partly been fossilized and partly not; but the position of the joints, one of which has a branch, is retained. This form is very like *Isis hippuris* of the Eastern seas.

Locality. Naigh-Nai valley, south-west of Sehwán, in the Gáj series. Survey-number G $\frac{302}{40}$.

Plate XXVIII. Fig. 10. The joints: natural size.

Isis, sp. 2.

The joint is moderately long, slender, exceedingly delicately and straightly grooved, faintly enlarged at the ends, and the joint-surface is concave. This form is allied to *Isis Peloritana*, Seg. *op. cit.* p. 16, from Messina, in the uppermost Miocene strata.

Height of specimen $\frac{6}{10}$ inch; breadth not quite $\frac{2}{10}$ inch.

Plate XXVIII. Fig. 11. A joint: natural size.

Isis, sp. 3.

The joints are long, well and pointedly convex at their ends, faintly yet decidedly grooved in a straight direction in some places and oblique in others. Small abortive branches are noticed, and the grooving is only just continued over the edge of the upper and lower surfaces. The ridges branch occasionally, and the body is slightly broader at the joint-ends than in the middle.

Length of joint $\frac{9}{10}$ inch; breadth $\frac{2}{10}$ inch.

Another specimen is shorter, but shows the peculiarities of the species.

Plate XXVIII. Fig. 12. Two joints: natural size.
13. The striation: magnified.
14. The convex upper surface: magnified.

These Isidine remains give a very late facies to the fossils of the Gáj or Miocene series of Sind.

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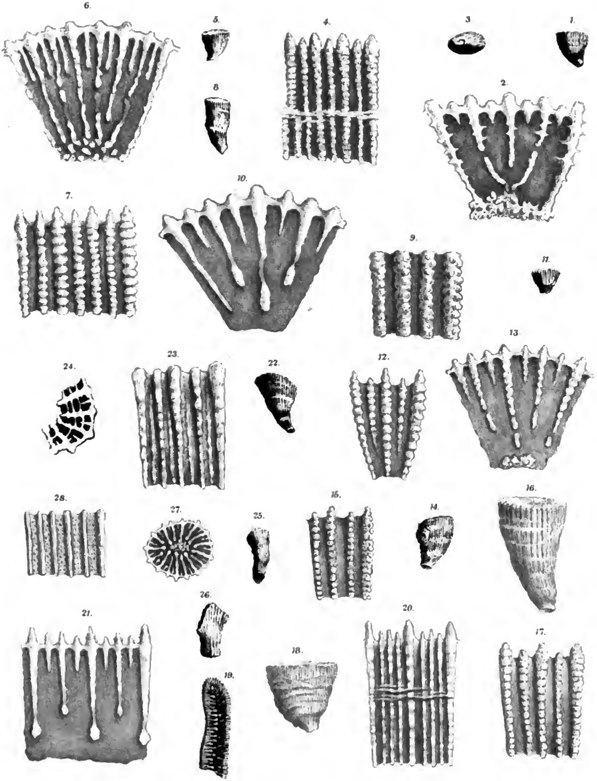
XV. *Description of the Plates.*

PLATE I.

Figure 1. Caryophyllia compressa, Duncan. A side view, natural size.
2. The calice of the coral, one system of its septa and pali, magnified.
3. The base of the same coral, natural size.
4. The costæ near the calice, magnified.
5. A side view of Caryophyllia Indica, Duncan, natural size.
6. A part of the calice, magnified, showing two systems of four cycles and pali.
7. The costæ, magnified.
8. Caryophyllia Feddeni, Duncan. A side view, natural size.
9. The costæ, magnified.
10. A part of a calice, magnified.
11. Trochocyathus Iakii, Duncan. A side view, natural size.
12. The costæ, magnified.
13. Part of a calice, magnified; pali before all the septa, except the smallest.
14. Smilotrochus Jakhmari, Duncan. A side view, natural size.
15. The costæ, magnified.
16. Another specimen, slightly magnified, side view.
17. Its costæ, magnified.
18. Smilotrochus Blanfordi, Duncan. A side view, natural size.
19. A part of the calice, natural size.
20. The costæ, magnified.
21. The septa, magnified. (See also Plate III. Figure 1.)
22. A side view of a young specimen.
23. The costæ, magnified.
24. Rhabdophyllia Barkii, Duncan. A magnified view of part of a fractured portion, showing dissepiments, and a rudimentary septum between the larger ones.
25. } Side views of the corallum of different specimens.
26. }
27. A calice, magnified.
28. The costæ, magnified.



G.R.Dewlie del. P.M.Duncan dir.

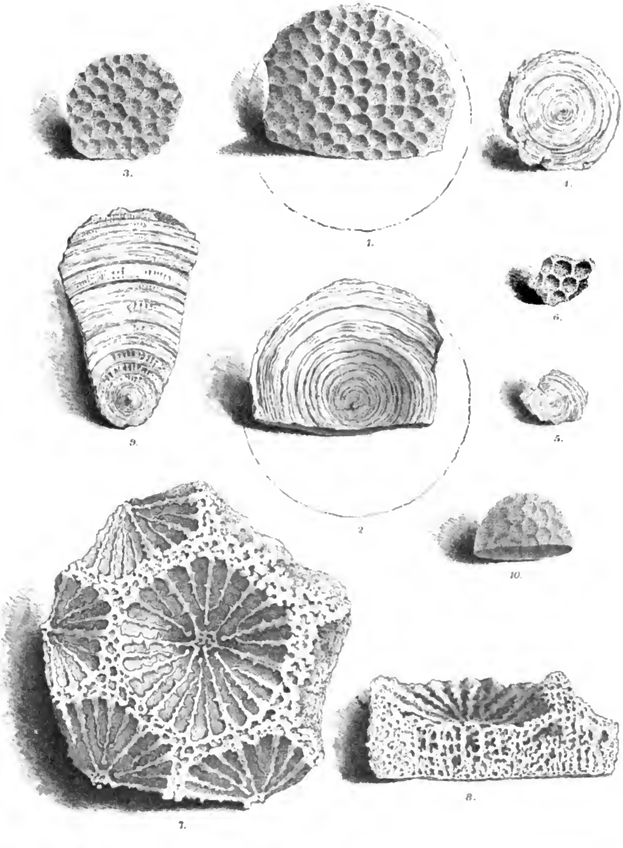
Fossil Corals from Scind.

Mintern Bros. imp.

PLATE II.

Figure 1. LithARÆA EPITHECATA, Duncan. The upper part of a broken corallum, natural size. The circular line gives the former dimensions of the coral.

2. The base of the same specimen.
3. The upper surface of a smaller specimen.
4. The base.
5. The base of a smaller specimen.
6. The calices, weathered.
7. The calices of Figure 1, highly magnified.
8. A side view of the edge of the corallum, to show the perforate condition of the septa, magnified.
9. A portion of the base, slightly magnified, to show faint costal striations.
10. A hemispherical variety.



G.R. Dewilde del. P.M. Duncan dir.

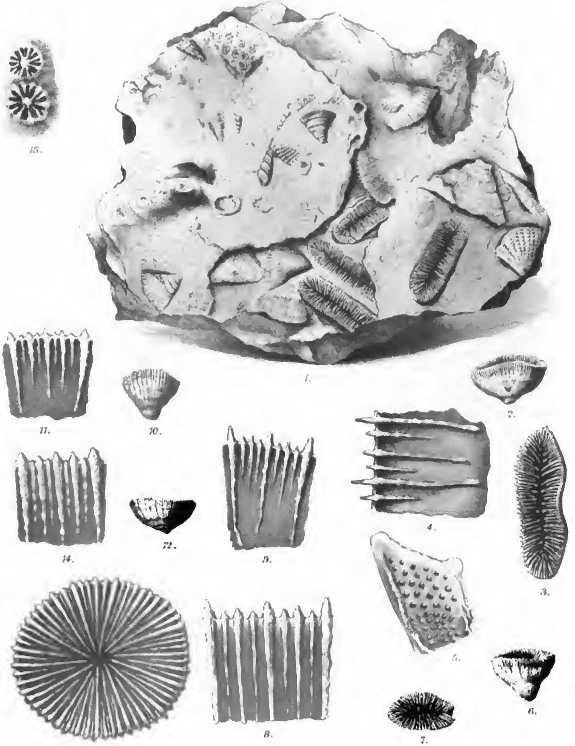
Mintern Bros imp.

Fossil Corals from Sind.

PLATE III.

Figure 1. A mass of olive shaly sandstone, with Mollusca and many specimens of embedded SMILOTROCHUS BLANFORDI, Duncan. Also a small portion of a *Stylophora*, magnified in figure 15.

2. TROCHOSMILIA MEDLICOTTI, Duncan. A moderate-sized specimen, side view.
3. Its calice, magnified.
4. The septa from a worn portion, magnified.
5. A side view of a septum, showing the large granules and some endotheca, magnified.
6. TROCHOSMILIA OLDHAMI, Duncan. The coral, natural size.
7. Its calice.
8. Costæ, magnified, the smaller being hidden by epitheca.
9. The triplets of small septa between the larger septa in the calice, magnified.
10. Another specimen, side view.
11. The septa, magnified.
12. MONTLIVALTIA RANIKOTI, Duncan. The coral, natural size.
13. The calice, magnified.
14. The costæ, magnified.
15. A portion of a STYLOPHORA, magnified.

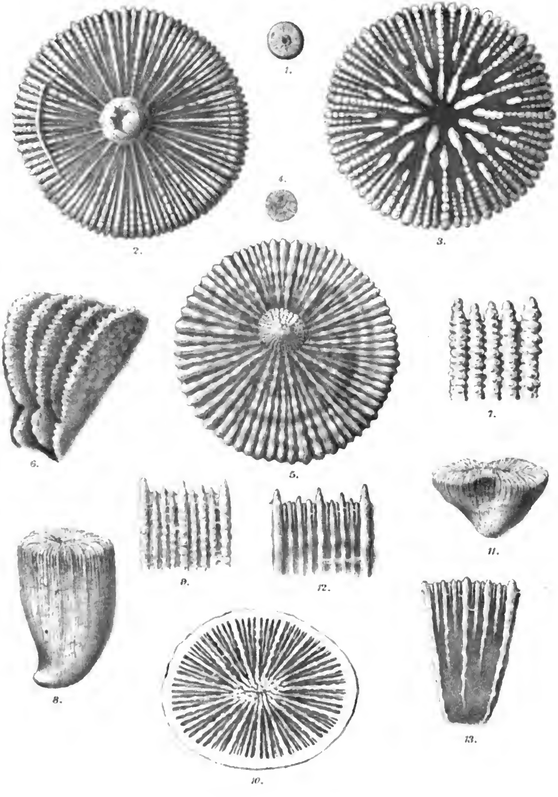


G. R. Dewkle del. P. M. Duncan dir. Mintern Bros imp.

Fossil Corals from Sind.

PLATE IV.

Figure 1. **Trochocyathus nummuliticus**, Duncan. The base of the coral, natural size.
2. The base, magnified, and its worn Nummulite.
3. The calice, magnified.
4. **Leptocyathus epithecata**, Duncan. The base of the coral, natural size.
5. The base on a Nummulite, magnified.
6. The granular septa and pali, magnified.
7. The costæ, magnified.
8. **Feddenia elongata**, Duncan. Side of the coral, rather smaller than nature.
9. The costæ, magnified.
10. A section of the coral, magnified.
11. **Trochosmilia Oldhami**, Duncan. A large specimen.
12. The costæ, showing the intermediate sets of three, magnified.
13. Worn-down septa, magnified.



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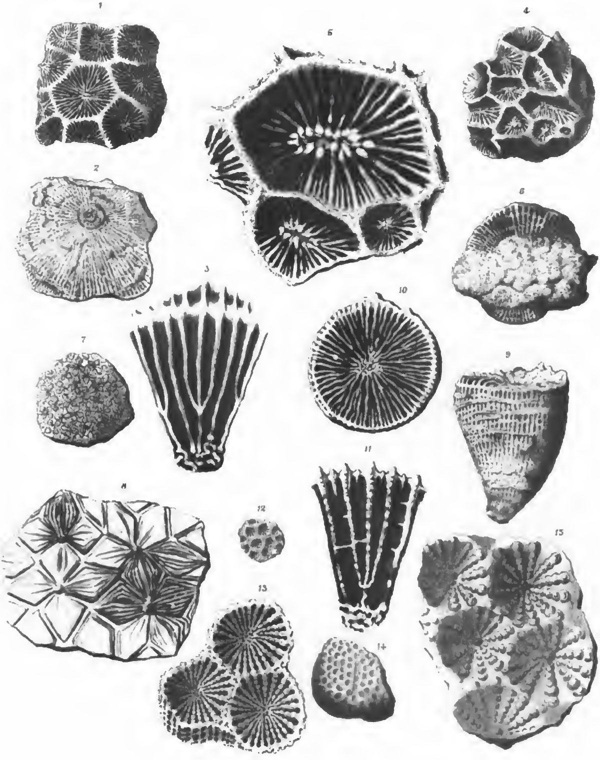
Fossil Corals from Sind.

PLATE V.

Figure 1. Prionastræa tenuiseptata, Duncan. The calices, very slightly enlarged.
2. The base of the corallum, natural size.
3. The junction of the septa and the columella, magnified.
4. Prionastræa insignis, Duncan. The upper surface of corallum, natural size.
5. The calices, magnified.
6. The base.
7. Pterastræa mirabilis, Duncan. The corallum in part, calicular surface, natural size.
8. Some calices, magnified.
9. Montlivaltia Vignei, D'Archiac and Haime. Side view of coral.
10. The calice, slightly magnified.
11. The junction of septa with a trabeculate columella and endotheca, magnified.
12. Porites Indica, Duncan. A part of the coral, slightly magnified.
13. Calices, magnified.
14. Porites Pellegrinii, D'Ach. The corallum.
15. Calices, magnified.



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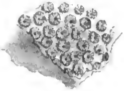
Fossil Corals from Sind.

PLATE VI.

Figure 1. Stylina tertiaria, Duncan. A part of the corallum, natural size.
2. Calices, magnified.
3. Favia Maliriensis, Duncan. Some calices, magnified.
4. Calices, magnified, showing large septo-costæ.
5. Favia pedunculata, Duncan. Part of the surface of the corallum.
6. Calices, slightly magnified.
7. Cyathoseris orientalis, Duncan. The side view.
8. Septa, magnified, showing synapticulæ.
9. Junctions of septa on a colline.
10. Costal striæ of under surface, magnified.
11. Diploria flexuosissima, D'Ach. A part of the corallum.
12. Two series, slightly magnified.
13. Astrocœnia numisma, Defrance, sp. Upper part of the coral, natural size.
14. Side view.
15. Calices, magnified.



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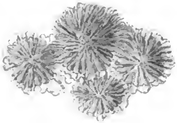

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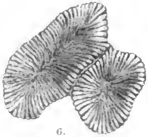

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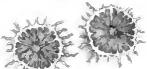

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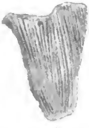

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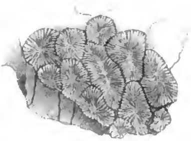

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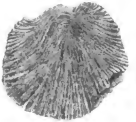

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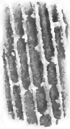

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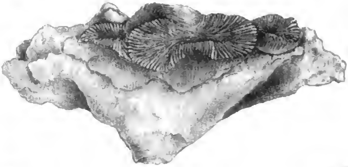

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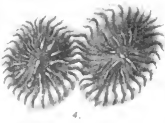

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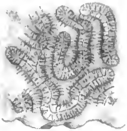

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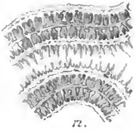

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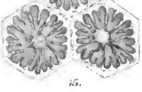

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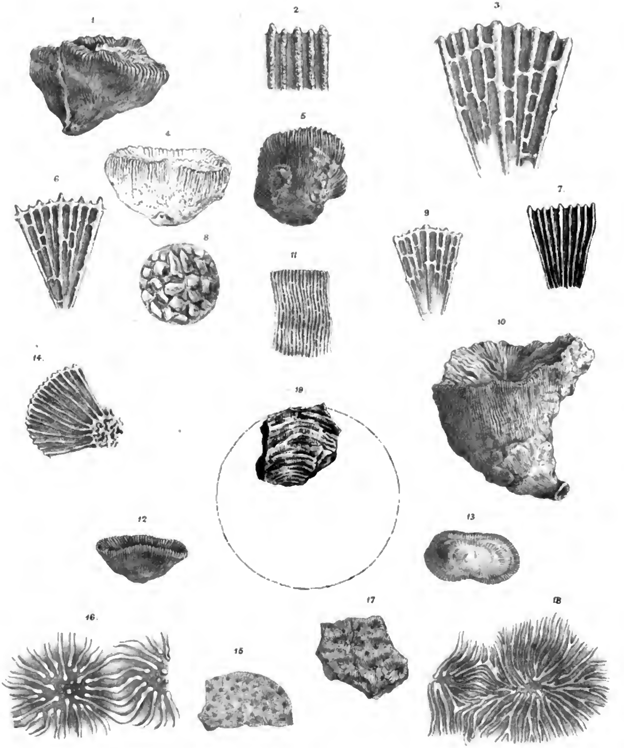
PLATE VII.

Figure 1. Turbinoseris Indica, Duncan. The corallum, natural size.
2. Costæ, magnified.
3. Septa and synapticulæ, magnified.
4. Turbinoseris Haimei, Duncan. Outline of the coral, natural size.
5. End view.
6. Septa, magnified.
7. Costæ, magnified.
8. Turbinoseris epithecata, Duncan. Epitheca, magnified.
9. Septa, magnified.
10. Turbinoseris Ranikoti, Duncan. The corallum, natural size.
11. Costa, magnified.
12. Trochocyathus corbicula, Duncan. The corallum, side view, natural size.
13. The base.
14. Part of the calice, magnified.
15. Astræa Morloti, Reuss. Part of corallum.
16. Calices, magnified.
17. Prionastræa Indica, Duncan. The corallum.
18. Calices, magnified.
19. Part of the base, indicating the shape of the coral.



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Fossil Corals from Sind.

PLATE VIII.

Figure 1. LEPTORIA HYDNOPHOROIDEA, Duncan. The corallum, natural size.
2. A series, magnified.
3. ELLIPTOSERIS APERTA, Duncan. The corallum, natural size.
4. Septa and pali, magnified.
5. A side of a septum, magnified.
6. A side of a septum and some of the pali, magnified.
7. STEPHANOPHYLLIA INDICA, Duncan. The corallum, natural size, side view.
8. The corallum from above, natural size.
9. The calicular surface, highly magnified.
10. The edge with trabecular septa, magnified.
11. TROCHOSMILIA VARICOSA, Reuss. The corallum, natural size.

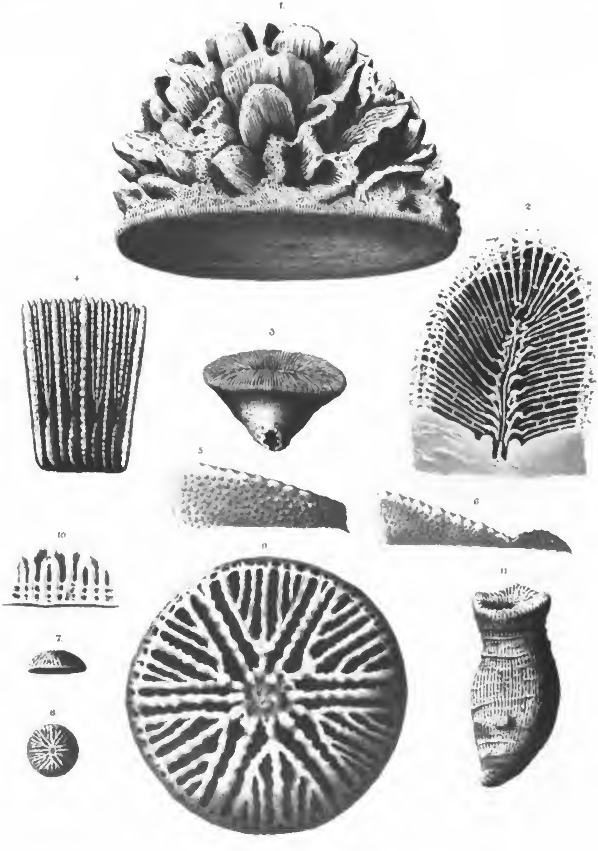

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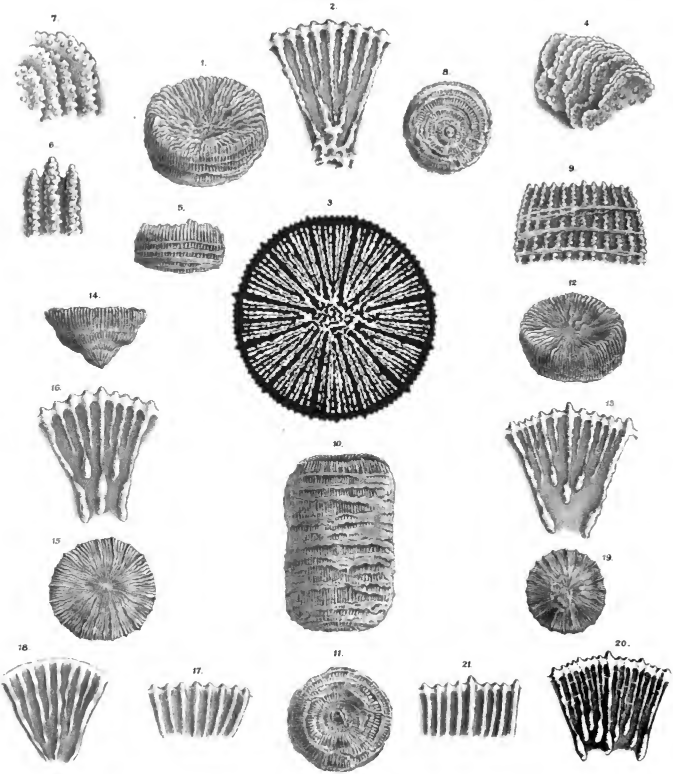
PLATE IX.

Figure 1. **Trochocyathus Nariensis**, Duncan. An oblique view, natural size.
2. Septa and pali, magnified.
3. A transverse section of a large specimen, slightly magnified.
4. The septa, obliquely seen, magnified.
5. The costæ and epitheca.
6. The costæ, magnified.
7. Oblique view of costæ at the margin, magnified.
8. The base, natural size.
9. The costæ and epitheca of a large specimen, slightly magnified.
10. Side view of a tall, old specimen, natural size.
11. Its base.
12. A variety of the species.
13. The septa and pali, magnified.
14. **Trochocyathus cyclolitoides**, Milne Edwards and Jules Haime. The coral, side view, natural size.
15. The calice, natural size.
16. The pali and septa, magnified.
17. The costæ near the calice, magnified.
18. A part of the base, magnified.
19. **Cyclolites orientalis**, Duncan. Calice, slightly enlarged.
20. The septa and their filiform ends, magnified.
21. Septa near the margin, magnified.

Plate IX.



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Fossil Corals from Sind.

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PLATE X.

Figure 1. REUSSASTRÆA GRANDIS, Duncan. A calice, magnified.
2. Calices, magnified.
3. Costæ, magnified.
4. Costæ on the base, magnified.
5. MONTLIVALTIA INDICA, Duncan. The corallum, natural size.
6. The base.
7. Part of some septa and endotheca, magnified.
8.
9. Side views of varieties of TROCHOSMILIA OLDHAMI, Duncan.
10.
11. STYLINA REUSSI, Duncan.
12. Calices, magnified.
13. Longitudinal section, showing columella, magnified.
14. The costæ, magnified.
15. MÆANDRINA MEDLICOTTI, Duncan. Part of corallum, natural size.
16. A portion of a series, magnified.

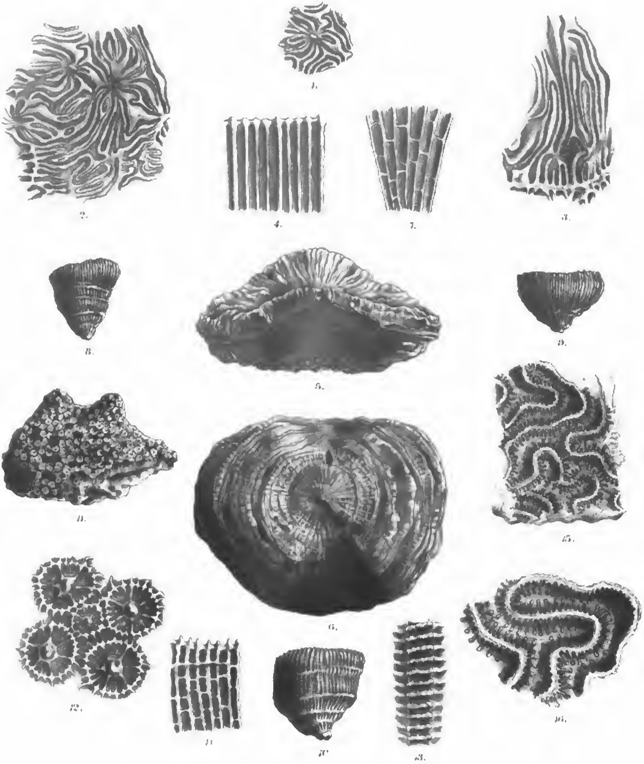

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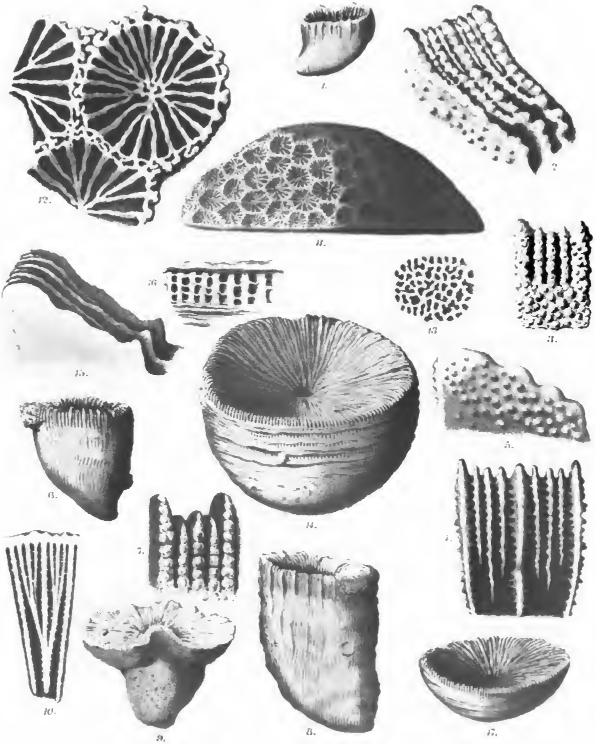
PLATE XI.

Figure 1. FEDDENIA TYPICA, Duncan. The corallum, side view, natural size.
2. A part of a calice, magnified.
3. Costæ and part of epitheca, magnified.
4. FEDDENIA TYPICA, variety 1. Septa, magnified.
5. Granules on a septum, magnified.
6. FEDDENIA TYPICA, variety 2. The corallum, natural size.
7. Costæ and septa, magnified.
8. FEDDENIA CRISTATA, Duncan. The corallum, natural size.
9. TROCHOSERIS DIFFORMIS, Reuss. The corallum, natural size.
10. Septa, magnified.
11. LITHARÆA GRANDIS, Duncan. The corallum, natural size.
12. Calices, magnified.
13. Reticulate appearance of costæ on the base, magnified.
14. MONTLIVALTIA GRANTI, J. Haime. The corallum, natural size.
15. Septa, magnified.
16. Costæ, exotheca, and epitheca, magnified.
17. A small and young specimen, natural size.



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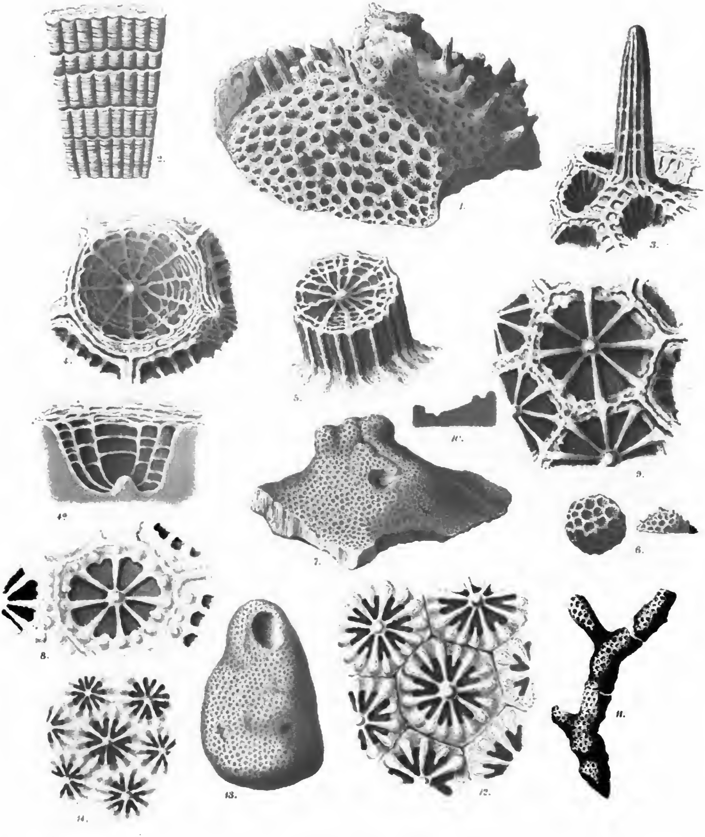
Fossil Corals from Sind.

PLATE XII.

Figure 1. Stylocœnia maxima, Duncan.
- 2. Portion of the base, magnified.
- 3. A pillar and calices, magnified.
- 4. A calice and margin, magnified.
- 4*a*. Side view of a calice, section.
- 5. Aborted calice on a pillar.
- 6. Small specimen, natural size, and part, magnified.
- 7. Astrocœnia gibbosa, Duncan. Natural size.
- 8. Calices with cœnenchyma and raised line, magnified.
- 9. Calices with granular cœnenchyma, magnified.
- 10. Side view of a septum, magnified.
- 11. Astrocœnia ramosa, Sowerby, var. minor. Corallum, natural size.
- 12. Calices, magnified.
- 13. Stylocœnia Taurinensis, Ed. & Haime. The corallum, natural size.
- 14. Calices, magnified.



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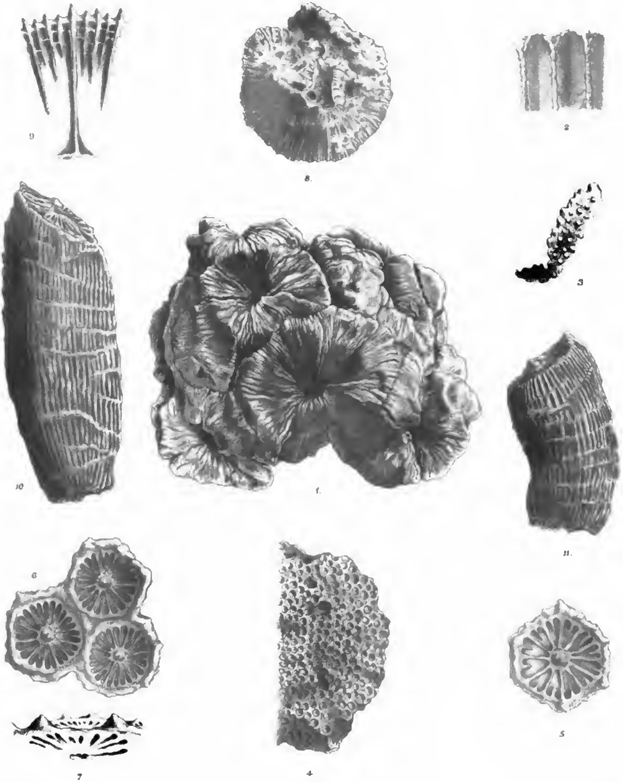
Fossil Corals from Sind.

PLATE XIII.

Figure 1. Plocophyllia Sindiana, Duncan. The corallum, natural size.
2. Costæ, magnified.
3. Free edge of a septum, magnified.
4. Stylocœnia Vicaryi, J. Haime. A part of the corallum, natural size.
5. A worn calice, magnified.
6. Calices, magnified.
7. Diagram of vertical edge of calicular margins, magnified.
8. Cyclolites alpina. The corallum, natural size.
9. Calicular septal edge, magnified.
10. Dasyphyllia gemmans, Duncan. A corallite, natural size.
11. Trochosmilia Dharanensis, Duncan. Natural size.



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Fossil Corals from Sind.

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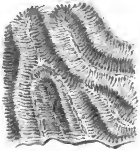
PLATE XIV.

Figure 1. Isastræa irregularis, Duncan. Some calices, magnified.

2. A variety: calices, magnified.
3. Pachyseris Murchisoni, D'Archiac and Haime. The upper surface of the corallum, natural size.
4. A part of a series, magnified.
5. Porites superposita, Duncan. The corallum, natural size.
6. A calice, magnified.
7. Astrocœnia cellulata, Duncan. Calices, magnified.
8. The corallum of Placocyathus striatus, Duncan. Natural size.
9. Columella and pali, magnified.
10. Costæ, magnified.
11. Blagrovia simplex, Duncan. The coral, natural size.
12. The base and costæ, magnified.
13. Septa at the calicular margin, magnified.



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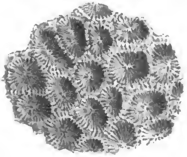

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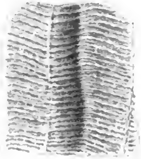

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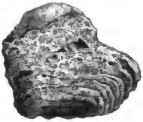

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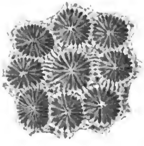

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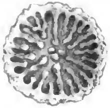

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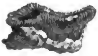

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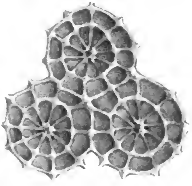

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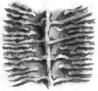

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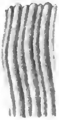

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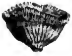

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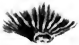

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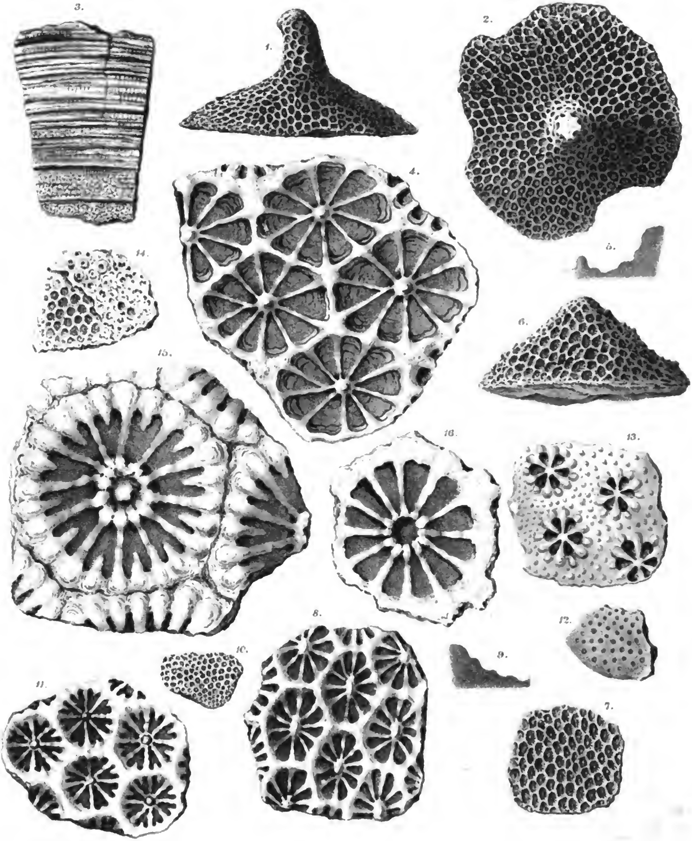
Fossil Corals from Sind.

PLATE XV.

Figure 1. **Astrocœnia Blanfordi**, nobis. The corallum, side view, natural size.
2. The corallum, from above.
3. A part of the base, magnified slightly.
4. Calices, magnified.
5. A dentate septum, magnified slightly.
6. **Stylocœnia Ranikoti**, nobis. Natural size.
7. The calices, slightly magnified.
8. The calices, more magnified.
9. A side view of a septum, magnified.
10. **Astrocœnia nana**, Reuss. A part of the corallum.
11. Calices, magnified.
12. **Stylophora pulcherrima**, D'Achiardi. Surface of the corallum, slightly magnified.
13. Calices and intermediate tissue, magnified.
14. **Stephanocœnia microtuberculata**, nobis. A part of the corallum.
15. Calices, magnified.
16. A calice with an aborted columella, magnified.



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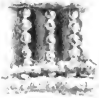
Fossil Corals from Sind.

PLATE XVI.

Figure 1. Montlivaltia Lynyani, Duncan. The corallum, side view, natural size.
2. Costæ and epitheca, magnified.
3. Turbinoseris elegans, Duncan. The corallum, side view, natural size.
4. Septa, magnified.
5. Plocophyllia flabellata, Reuss. The corallum, side view, natural size.
6. The costæ, magnified.
7. Cycloseris Perezi, M. Edw. & Haime. The calice, natural size.
8. Showing the everted margin and costæ, magnified.
9. Trochocyathus Nariensis, variety. The calice, natural size.
10. Septa and pali, magnified.
11. Cyclolites Altavillensis, Defr. The corallum, side view, natural size.



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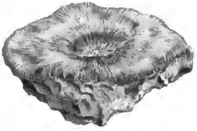

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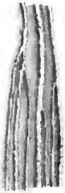

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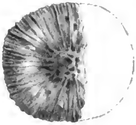

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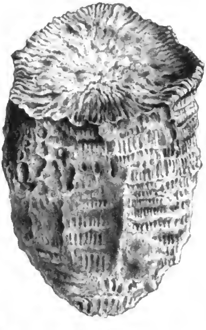

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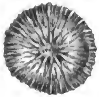

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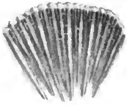

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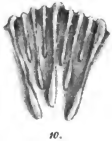

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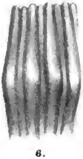

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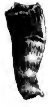

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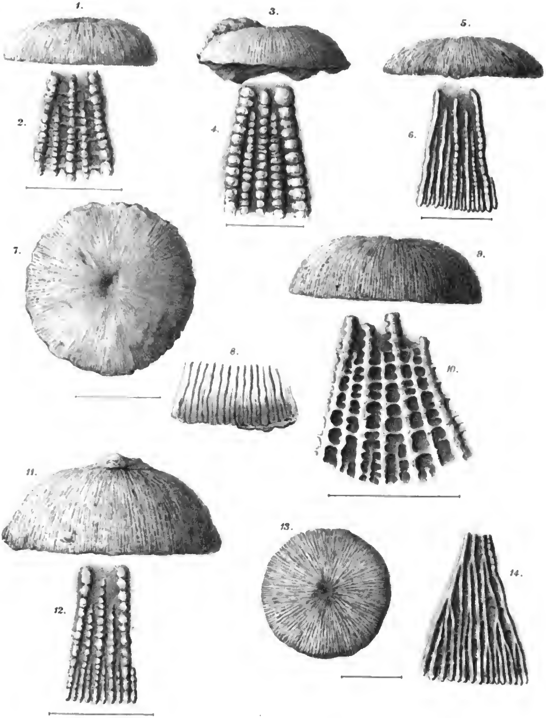
Fossil Corals from Sind.

PLATE XVII.

Figure 1. Cyclolites Vicaryi, Haime, natural size, side view.
2. Some septa, magnified.
3. Cyclolites crenulata, Duncan, side view, natural size.
4. Some septa, magnified.
5. Cyclolites Ranikoti, Duncan, side view.
6. Septa and synapticulæ, magnified.
7. Cyclolites striata, Duncan, natural size.
8. Septa near the edge, magnified.
9. Cyclolites Haimei, Duncan, natural size.
10. Septa and synapticulæ, magnified.
11. Cyclolites superba, Duncan, side view.
12. Septa, magnified.
13. Cyclolites anomala, calice, natural size.
14. Septa forming near fossa, magnified.



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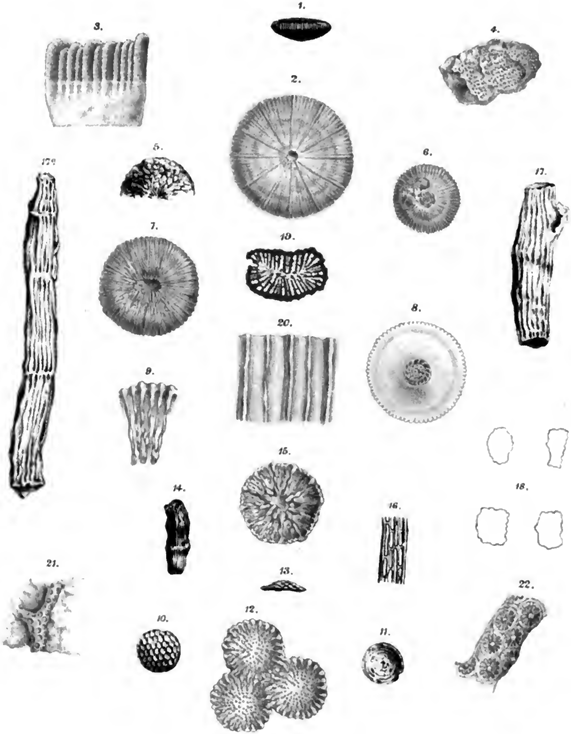
Fossil Corals from Sind.

PLATE XVIII.

Figure 1. Trochocyathus Burnesi, J. Haime. Side view of the corallum, natural size.
2. The base, slightly enlarged.
3. A side view of the costæ, magnified.
4. The ornamentation of the septa, magnified.
5. A young coral, the epitheca magnified.
6. The costæ and base of a younger coral, magnified.
7. Blanfordia nummiformis, Duncan. The calice, magnified.
8. The base, magnified.
9. Some septa, magnified.
10. Isastræa punctata, Duncan. The corallum from above, natural size.
11. The base, magnified.
12. Calices, magnified.
13. Side view of the corallum.
14. Rhabdophyllia Nariensis, Duncan. The corallum, natural size.
15. A transverse section, magnified.
16. Costæ, magnified.
17. Calamophyllia elongata, Duncan. Corallites, natural size.
17 *a*. A long corallite.
18. Outlines of calices.
19. A transverse section of a corallite, magnified.
20. Costæ, magnified.
21. Stylophora contorta, Leymerie, sp. The branch, natural size.
22. Calices, magnified.



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Fossil Corals from Sind.

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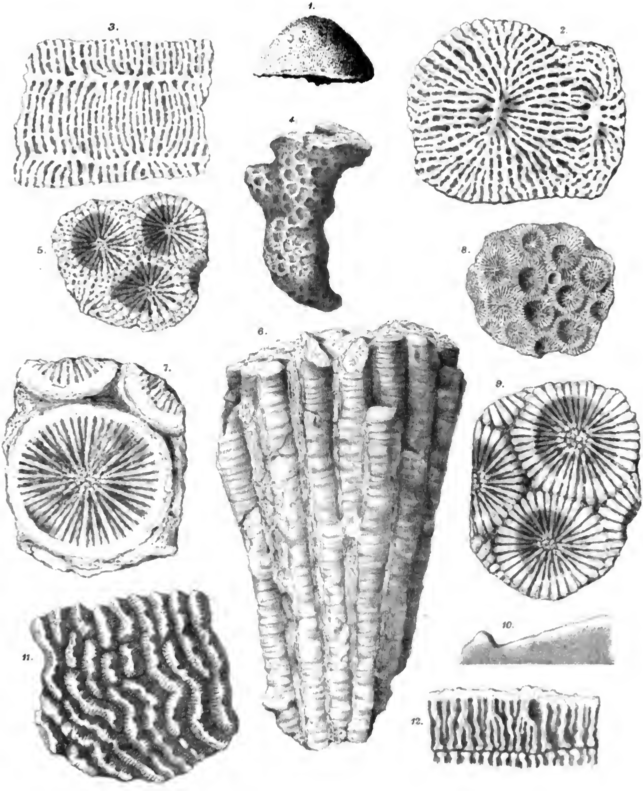
PLATE XIX.

Figure 1. A small corallum of Thamnastræa Balli, Duncan. Natural size.
2. Some calices, magnified.
3. A long calice, magnified.
4. Litharæa nodulosa, Duncan. The coral, natural size.
5. A calice, magnified.
6. Calamophyllia Indica, Duncan. The corallum, natural size.
7. A transverse section of a corallite, magnified.
8. Plesiastræa Eocenica, Duncan. A part of the calicular surface of the corallum, natural size.
9. Calices, magnified.
10. A diagram of a septum and palus.
11. Hydnophora Maliriensis, Duncan. A part of the corallum, natural size.
12. A colline, magnified.



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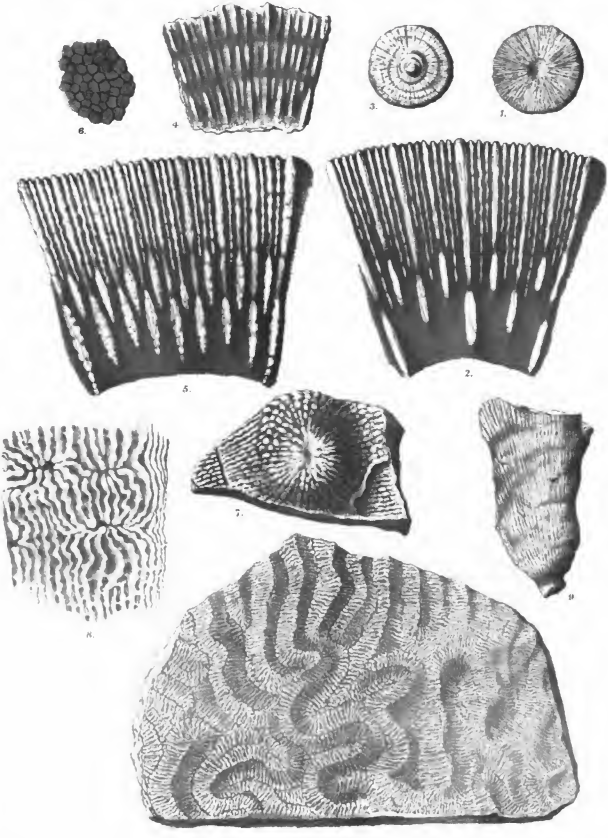
Fossil Corals from Sind.

PLATE XX.

Figure 1. Trochocyathus nummiformis, Duncan. The corallum from above, natural size.
2. Septa and pali, magnified.
3. The base, natural size.
4. The central part of the base, magnified.
5. The pali of variety 1.
6. The columella of variety 2.
7. Echinopora maxima, Duncan. Natural size of part of corallum.
8. Agaricia Danæ, Duncan. Calices, magnified.
9. The back and base of the corallum, natural size.
10. Latimæandra insignis, Duncan. Half of the corallum, natural size.

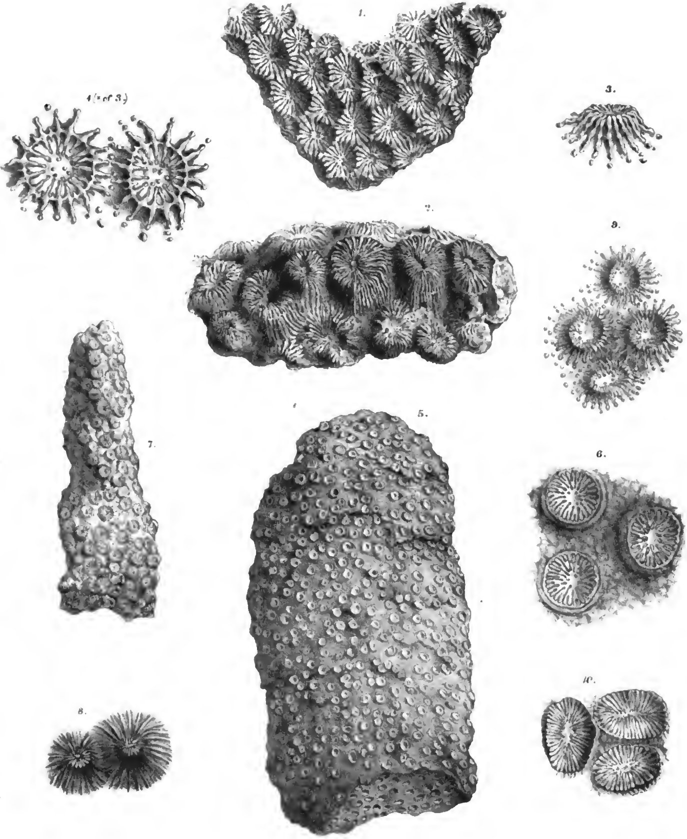


G.R. Dewalo del. P.M. Duncan dir.   Mintern Bros. imp.

Fossil Corals from Sind.

PLATE XXI.

Figure 1. **Prionastræa fungiformis**, Duncan. Portion of upper surface of corallum, natural size.
2. **Brachyphyllia Indica**, Duncan. Part of corallum, natural size.
3. **Plesiastræa decipiens**, Duncan. Part of corallum, natural size.
4. Calices, magnified.
5. **D'Achiardia densa.** The corallum, natural size.
6. Calices, magnified.
7. **Heliastræa digitata.** The corallum, natural size.
8. Calices, magnified.
9. **Plesiastræa pedunculata.** Some calices, natural size.
10. **Heliastræa anomala.** Some calices, natural size.



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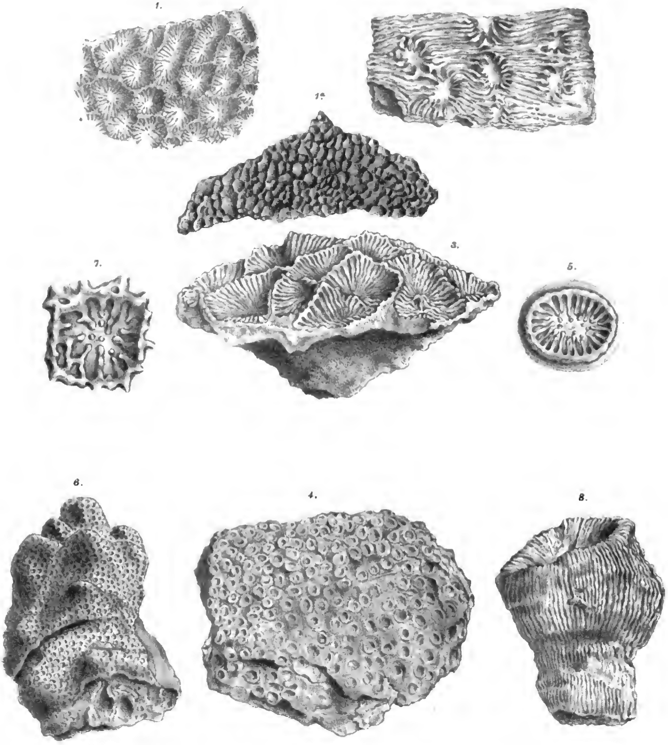
Fossil Corals from Sind.

PLATE XXII.

Figure 1. Latimæandra parvula, Duncan. Calices, magnified.
1*. Part of the corallum, natural size.
2. Echinopora miocenica, Duncan. Upper surface of a worn corallum, natural size.
3. Prionastræa Gajensis, Duncan. The corallum, natural size.
4. D'Achiardia lobata, Duncan. Upper surface of corallum, natural size.
5. A calice, magnified.
6. Porites Gajensis, Duncan. The corallum, natural size.
7. A calice, magnified.
8. Leptomussa rugosa, Duncan. The corallum, natural size.



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Mintern Bros imp.

Fossil Corals from Sind.

PLATE XXIII.

Figure 1. **Leptoria concentrica**, Duncan. The corallum, natural size.
2. Septa, magnified.
3. **Trochocyathus Gajensis**, Duncan. Side view of coral, natural size.
4. The base and costæ, slightly magnified.
5. **Antillia plana**, Duncan. The corallum, natural size.
6. **Stylophora minuta**, var., Duncan. Calices, magnified.
7. **Stylophora confusa**, Duncan. Calices, magnified.
8. **Cladocora Haimei**, Duncan. Side view of pieces of a corallum.
9. Calice, magnified.
10. **Dasyphyllia**, species. Part of a corallum, natural size.

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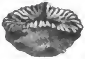

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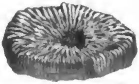

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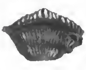

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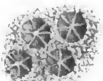

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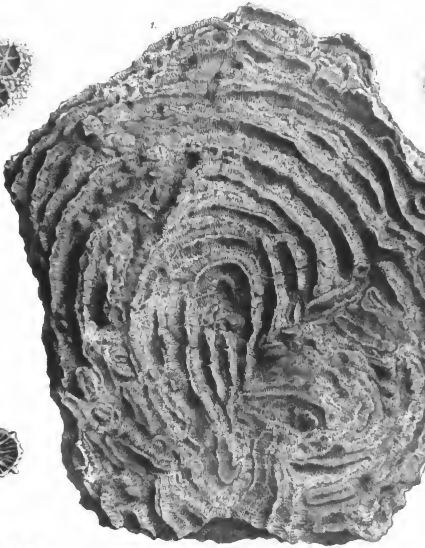

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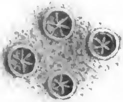

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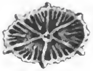

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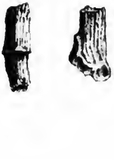

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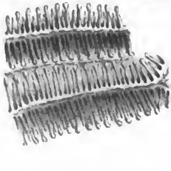

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Fossil Corals from Sind

PLATE XXIV.

Figure 1. A calicular view of a corallum of LATIMÆANDRA PARVULA, Duncan, with long series, natural size.

2. CARYOPHYLLIA GAJENSIS. The corallum, side view.
3. The calice, slightly magnified (× 1·5).
4. MONTLIVALTIA JACQUEMONTI, D'Archiac & Haime. The corallum, natural size.
5. PACHYSERIS EXARATA, Duncan. The corallum, natural size.
6. A portion, magnified.
7. PACHYSERIS AFFINIS, Duncan. A portion of the coral, natural size.
8. A portion, magnified.
9. PLESIASTRÆA COSTATA, Duncan. A portion of the coral, natural size.
10. A calice, oblique view, magnified.
11. ANTILLIA INDICA, Duncan. The corallum and calice, natural size.

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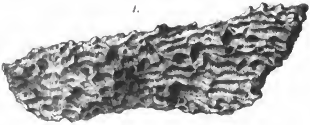

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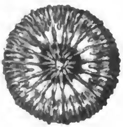

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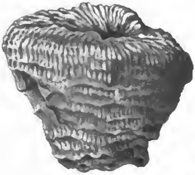

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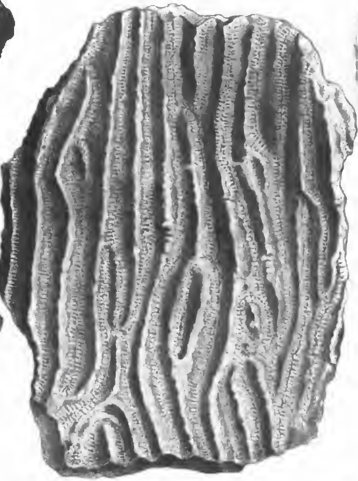

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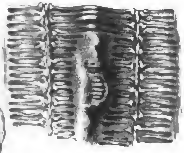

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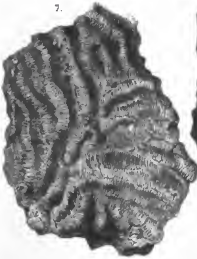

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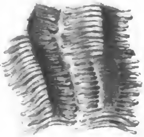

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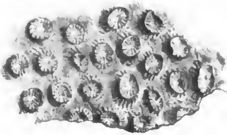

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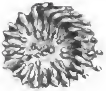

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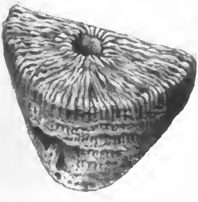

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Fossil Corals from Sind.

PLATE XXV.

Figure 1. **Stephanocœnia maxima**, Duncan. A calice, magnified.
2. A calice, seen obliquely, magnified.
3. **Latimæandra Gajensis**, Duncan. Some calices, natural size.
4. Calices, magnified.
5. **Latimæandra Reussi**, Duncan. A part of the corallum, natural size.
6. **Astræopora hemisphærica**, Duncan. The corallum, natural size.
7. **Turbinaria Sitaensis**, Duncan. Part of the corallum, natural size.
8. A portion of the upper surface, magnified.
9. **Madrepora**, sp. A branchlet, natural size.

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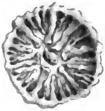

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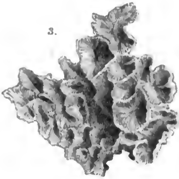

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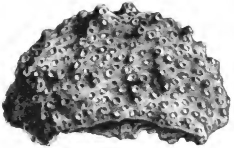

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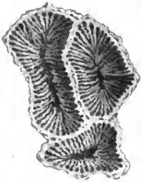

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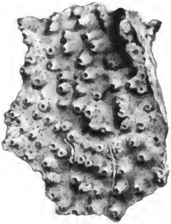

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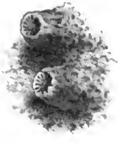

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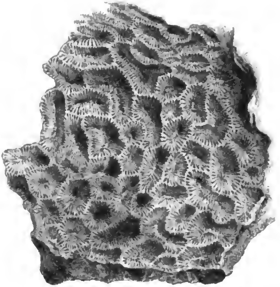

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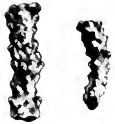

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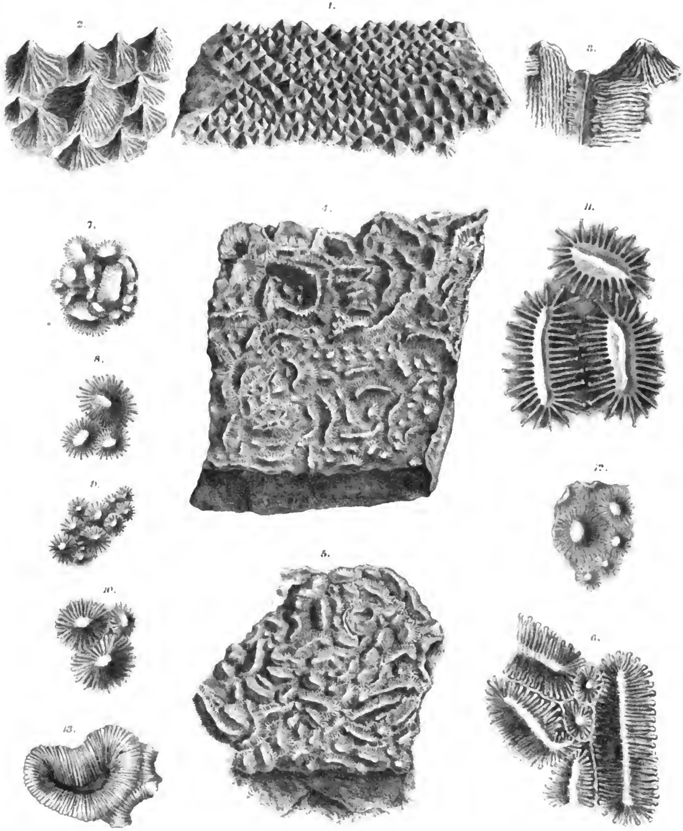
Fossil Corals from Sind.

PLATE XXVI.

Figure 1. Monticulastræa insignis, Duncan. A part of the corallum, natural size.
2. Some collines, magnified.
3. A longitudinal section, showing the columella and endotheca, magnified.
4. Monticulastræa inæqualis, Duncan. A part of the top of the corallum, natural size.
5. Monticulastræa solidior, Duncan. A part of the upper portion of the coral, natural size.
6. A colline, magnified.
7. Hydnophora rudis, Duncan. A part of the upper surface of the coral, natural size.
8. Some collines, slightly magnified.
9. Hydnophora plana, Duncan. A part of the calicular surface.
10. Collines, slightly magnified.
11. Hydnophora Danæ, Duncan. Some collines, magnified.
12. Hydnophora hemisphærica, Duncan. Collines, magnified.
13. Cycloseris magnifica, Duncan. A calice, slightly magnified.



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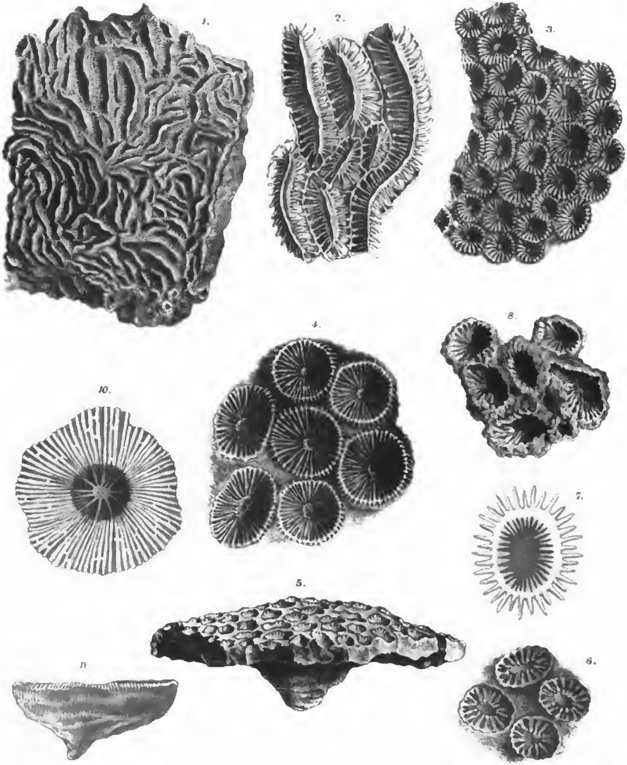
Fossil Corals from Sind.

PLATE XXVII.

Figure 1. Monticulastræa elongata, Duncan. A part of the corallum, natural size.
2. Collines, magnified.
3. Heliastræa Sindiana, Duncan. A part of the corallum, natural size.
4. Calices, magnified.
5. Phyllocœnia conferta, Duncan. The corallum, natural size.
6. Calices, magnified slightly.
7. A calice with costæ, magnified.
8. Cyathoseris irregularis, Duncan. A worn specimen, natural size.
9. Trochoseris aperta, Duncan. A side view, natural size.
10. The calice, magnified.



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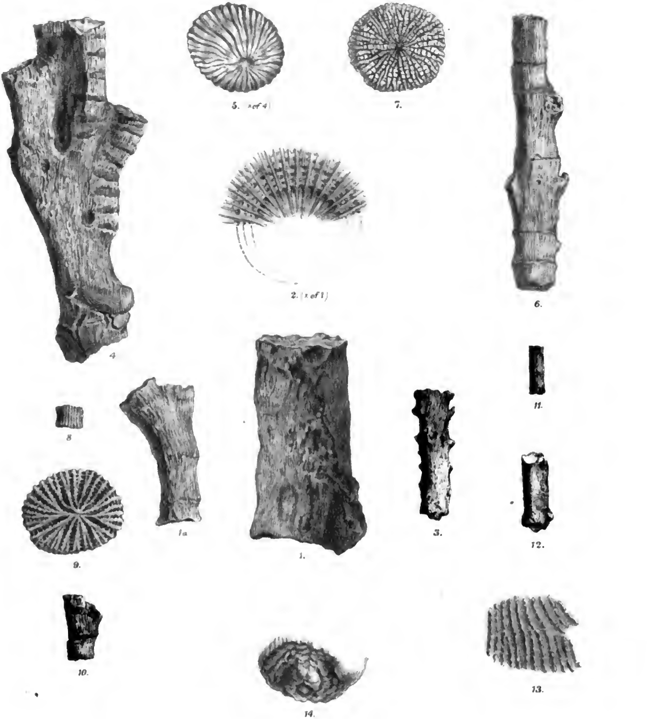
Fossil Corals from Sind.

PLATE XXVIII.

Alcyonaria.

Figure 1. **Isis Danæ**, Duncan. A large joint, natural size.
2. End of a joint, showing the radii, magnified.
3. A variety. The joints with lateral projections, natural size.
4. **Isis compressa**, Duncan. The stem, natural size.
5. The top of a joint, magnified.
6. **Isis elongata**, Duncan. Portions of the stem and joints, natural size.
7. A transverse section, slightly magnified.
8. Isis, species 1. A joint, side view, natural size.
9. The upper surface, slightly magnified.
10. Joints of another Isis, natural size.
11. Isis, species 2. A joint, natural size.
12. Isis, species 3. Two joints, natural size.
13. The striation, magnified.
14. The convex upper surface, magnified.



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Fossil Alcyonaria from Sind.

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MEMOIRS
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GEOLOGICAL SURVEY OF INDIA.

Palæontologia Indica,

BEING

FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING
THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

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Series XIV. TERTIARY AND UPPER CRETACEOUS FAUNA OF WESTERN INDIA.

VOL. I.

Part 4. THE FOSSIL ECHINOIDEA OF KACHH AND KATTYWAR.

WITH 13 PLATES.

BY
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SOCIETY; PROFESSOR OF GEOLOGY IN KING'S COLLEGE, LONDON; CORRESPONDENT OF THE
ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA, ETC.,

AND

W. PERCY SLADEN, F.G.S., F.L.S., &c.

WITH AN INTRODUCTION BY
W. T. BLANFORD, ESQ., F.R.S., F.L.S., F.Z.S., &c.,
LATE OF THE GEOLOGICAL SURVEY OF INDIA.

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PREFACE.

HAVING completed the descriptions of the Fossil Echinoidea from the two lower horizons of the Tertiaries of Western Sind, we began to study the forms which were found in the Khirthar and Nari series of that country. In all this research we obtained but little assistance from the many admirable works which have of late years been written on the Tertiary Echinoidea. We found that we were working amongst faunas which were singularly isolated. Moreover, not a little perplexity was caused by our inability to discover traces of many of the species which were described by d'Archiac and Haime in their classical work, 'Sur les Animaux Fossiles de l'Inde,' as characterizing Nummulitic strata.

Some very valuable descriptions of Egyptian and Lybian Nummulitic Echinoidea have lately been published by de Loriol; and we considered that it might be advisable to investigate the fine collection of Echinoidea from the Tertiaries of Kachh and Kattywar which had been carefully collected by the Geological Surveyors of India under the care of H. B. Medlicott, Esq., F.R.S., the Superintendent of the Survey. We hoped to trace affinities between the Sindian and Kachh faunas on the one hand, and between those of Egypt and Kachh and Kattywar on the other. Hence this work appears before our Memoirs on the Fossil Echinoidea of Western Sind are completed.

LIST OF BOOKS CONSULTED.

De Loriol. "Monographie des Echinides contenus dans les couches Nummulitiques de l'Egypte." Mém. Soc. de phys. et d'hist. nat. de Genève, vol. xxvii.; and Paris, 1881.

De Loriol. "Eocäne Echinoideen aus Aegypten und der libyschen Wüste." 'Palæontographica,' 1883.

De Loriol. Description des Echinides tertiaires de la Suisse. Genève, 1875.

W. Dames. "Die Echinoiden der vicentinischen und veronesischen Tertiärablagerungen." 'Palæontographica,' Cassel, 1877.

A. Agassiz. Revision of the Echini.

A. Agassiz. Report on the Echini of the 'Challenger' Expedition.

A. Agassiz. Report on the Echini of the 'Blake' Expedition.

S. Lovén. Etudes sur les Echinoïdées. Stockholm, 1874.

Desor. Synopsis des Echinides fossiles.

J. E. Gray. Catalogue of the Recent Echinida in the British Museum. 1855.

E. Forbes. Echinodermata of the British Tertiaries. Palæontographical Society, 1852.

Laube. "Echinodermen des vicentinischen Tertiärgebietes." Abhandlungen der k.-k. Akad. der Wissenschaften zu Wien, 1868.

Laube. "Die Echinoiden der österreichisch-ungarischen oberen Tertiärablagerungen." Abhandl. der k.-k. geol. Reichsanstalt, Wien, 1871, Band V. Heft 3, p. 55.

Manzoni. "Echinodermi fossili della Molassa serpentinosa." Denkschriften der kaiserl. Akad. der Wiss. Wien, 42 Band, 1880, p. 185.

K. v. Fritsch. 'Palæontographica.' Cassel, 1877. Supp. III. Lief. i. Heft 2. "Die Echiniden der Nummuliten-Bildungen von Borneo."

Cotteau. "Echinides du Calcaire grossier de Mons." Mém. Cour. de l'Acad. Roy. de Belgique, 4to, xlii., 1879.

Cotteau. "Echinides tertiaires de la Belgique." *Ibid.* xliii., 1880.

Cotteau. Echinides des Pyrénées. Paris, 1863.

Cotteau. "Echinides tertiaires des environs de Bordeaux." Act. Soc. Linn. de Bordeaux, t. 27, 1869.

Cotteau. "Echinides nouveaux ou peu connus." Revue et Mag. de Zool., 1866.

Cotteau. Echinides des îles Saint-Barthélemy et d'Anguilla. 1875.

Cotteau. "Echinides fossiles de l'île de Cuba." Liége, 1881. Ann. de la Soc. Géol. de Belg. t. ix., Mémoires, p. 3.

Cotteau. "Echinides nouveaux ou peu connus." Bull. Soc. Zool. de France, t. vii., 1882.

A. Bittner. "Beiträge zur Kenntniss der alttertiärer Echinidenfauna der Südalpen."

Taramelli. "Di alcuni Echinidi eocenici dell' Istria." Atti del regio istituto Veneto di Sci. ser. 4, t. 3. 1873–74.

Pávay. Die fossilen Seeigel des Öfner Mergels.

Duncan. "Echinodermata of the Australian Cainozoic Deposits." Quart. Journ. Geol. Soc. Feb. 1877.

Duncan. "Morphology of Temnopleuridæ." Journ. Linn. Soc., Zool. vol. xvi. no. 93, p. 43. 1882.

Duncan and Sladen. Fossil Echinoidea of W. Sind. Palæontologia Indica, Ser. xiv.

Tournouër. "Recensement des Echinodermes du Calcaire à Astérics." Act. de la Soc. Linn. de Bordeaux, 1870.

Michelin. "Monogr. des Clypéastres fossiles." Mém. Soc. Géol. de France, 2 sér. t. vii.

Herklots. Fossiles de Java : Echinodermes.

Medlicott and Blanford. Abstract of the Geology of India.

Mourlon. Géologie de la Belgique. 1881.

C. W. Grant. "Geology of Cutch." Trans. Geol. Soc. 2 ser. vol. v. pt. 2. 1840.

Wynne. Mem. Geol. Survey India, ix.

Fuchs, T. "Beiträge zur Kenntniss der Miocänfauna Aegyptens und der libyschen Wüste." Palæontographica, 1883.

A DESCRIPTION

OF THE

TERTIARY FOSSIL ECHINOIDEA

OF

KACHH AND KATTYWAR.

I. *Remarks on the Geology of Kachh in Relation to that of Sind and Kattywar.*

By W. T. Blanford, F.R.S., late of the Geological Survey of India.

My friend Professor P. Martin Duncan has asked me to write a few lines on the Tertiary rocks of Cutch (Kutch or Kachh) and their connexion with the corresponding formations of Sind, as an introduction to the description of the Cutch Tertiary Echinoidea. I have much pleasure in aiding so far as I am able in explaining the relations of the beds; and I find that some explanation is necessary, owing to the terms applied to the Kachh groups by Mr. Wynne, and adopted in the 'Manual of the Geology of India' by Medlicott and Blanford, having been applied in a somewhat different sense by Mr. Fedden in the lists of localities sent with the fossils now described.

Before proceeding to details, it will be useful to notice the general characters and position of the Cutch Tertiary rocks, their connexion with the formations of the same age in Sind, Kattywar, &c., and the accounts given of them by different observers.

Kachh, or Cutch, it is scarcely necessary to say, is a district lying east of the mouths of the Indus, and surrounded on three sides by a flat marshy plain called Ran, and composed of alluvial deposits, the fourth or south side bordering the sea and the Gulf of Cutch. The Tertiary rocks occupy a belt, varying in breadth from about 4 miles to 20, between the alluvium near the coast and the older Mesozoic rocks in the interior. The Tertiary belt laps round the older rocks to the westward, where the whole of the Tertiary series is best exposed, and a few outliers occur even north of the Mesozoic area.

West and north-west of Cutch a wide area is occupied by the Indus delta, and the Tertiary beds only reappear in Sind after an interval of about 80 miles. There is nearly the same break to the southward before the corresponding formations are met with in Kattywar. The Sind beds form a part of the widely developed Tertiary region that extends northward to the foot of the Himalayas, and westward to the Persian Gulf or even further. The classification of the Sind Tertiary beds has already been explained*, and the different subdivisions may now be accepted, on the evidence of the corals and Echinoidea, as occupying the following position in the geological series:—

Manchhar or Siwalik, Upper	Pliocene.
„ „ Lower	Upper Miocene.
Gáj	Miocene.
Nari, Upper	Lower Miocene.
„ Lower	Oligocene.
Khirthar	Eocene.
Ranikot	Lower Eocene.

The beds beneath the Ranikot group form apparently a passage to the Cretaceous system.

Of these different groups the Lower Nari and the Gáj, both highly fossiliferous marine formations, occur with but little change throughout Sind; both, however, disappear completely further north. The Ranikot appears to be purely local, and is confined to the country near Tatta, Jhirak, and Kotri. The Khirthar group comprises the massive Nummulitic limestone of the Baluchistan frontier, in places 1500 to 3000 feet thick, and a great thickness of shales, marls, and sandstones beneath the limestone. Some of these shales and marls on the frontier of Northern Sind and to the westward may represent the Ranikot group of the Lower Indus valley, although they do not contain its peculiar fauna. Where the Khirthar beds rest upon the Ranikot group they have lost greatly in thickness, the great limestone bed is represented by a number of thinner beds interstratified with sandy and shaly deposits, and the fauna, although rich, differs materially from that of the great limestone band of Northern Sind. Further research to the northward has shown, in fact, that these great belts of Nummulitic limestone are of very irregular occurrence, that they vary in thickness by thousands of feet in the course of a few miles, and that they may occur at different horizons in the Eocene system.

The Tertiary rocks of Kachh were divided by Captain Grant†, the first geological explorer of the province, into Nummulitic and Tertiary, the former, in accordance with the views prevalent at the time, being considered Pre-Tertiary. MM. d'Archiac and Haime, however, classed both divisions as Eocene; and their views, which were quite erroneous, have long misled geologists both in India and Europe. Mr. Wynne, in his

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* "Fossil Corals of Sind," Pal. Ind. ser. xiv. vol. i. 1880.

† Trans. Geol. Soc. ser. ii. vol. v. pp. 300, &c.

Memoir on the Geology of Cutch, classed the Tertiary beds thus (Mem. Geol. Surv. Ind. vol. ix. p. 75, and MSS.):—

F. Upper Tertiary.
E. Argillaceous group.
D. Arenaceous group.
C. Nummulitic group.
B. Gypseous shales.
A. Subnummulitic.

The lower four subdivisions, A, B, C, D, he considered Eocene, the group E Upper Eocene or Miocene, F the Upper Tertiary, Miocene, or Pliocene. In the 'Manual of the Geology of India,' p. 344, the only important modification was that the Argillaceous group E was classed as Miocene, and equivalent to the Gáj group of Sind, the Arenaceous group being supposed, though with much doubt, to be the same as the Sind Nari.

In the collection of Cutch Echinoidea sent to England for examination the specimens are labelled from two subdivisions, the "Nummulitic" and the "Arenaceous group." There is clearly a mistake in the latter name, for the fossils are shown, by their nature and localities, to be from the "Argillaceous group" of Mr. Wynne's memoir and map. These beds are the Tertiary beds of Captain Grant, and are now shown by the examination of the fossils to be of Miocene age. It will be well in future to cease to employ these local terms of Arenaceous and Argillaceous groups; like other mineral terms they are liable to mislead, and in this case they have been confounded. It is clear that the Miocene beds of Cutch are allied to the Miocene or Gáj of Sind, some of the fossils, as *Breynia carinata* (the most characteristic Gáj species) and *Cœlopleurus Forbesi*, being identical. Whether there is any difference will probably be better decided after the Echinoidea from the Gáj series are examined.

It appears also that representatives of the Nari or Oligocene limestone occur in Cutch, where they have not been distinguished on the map from the Eocene Nummulitics (in Sind the separation was entirely due to an examination of the species of Foraminifera occurring). The Arenaceous group of Mr. Wynne's memoir and of the manual, but not of the present monograph, corresponds, both in position and mineral character, with the sandy Upper Nari group of Sind—a somewhat important subdivision, as it has now been traced northward up the Sulemán range of the Western Punjab.

The Kattywar Echinoidea are all Miocene; but it is possible that a thin representative of the Eocene system occurs in Kattywar, as it certainly does in Eastern Guzerat near Surat. Kattywar is now undergoing examination by Mr. Fedden, whose description has not yet been published.

II. *List of the Species of Fossil Echinoidea from the Nummulitic Series of Kachh.*

Order **ECHINOIDEA ENDOCYCLICA.**

Family GLYPHOSTOMATA.

Subfamily Temnopleuridæ.

Genus Arachniopleurus, *Duncan & Sladen*, 1882.

Arachniopleurus reticulatus, var., *Duncan & Sladen*: p. 11.

Order **ECHINOIDEA EXOCYCLICA.**

Suborder GNATHOSTOMATA.

Family CLYPEASTRIDÆ.

Subfamily Euclypeastridæ.

Genus Sismondia, *Desor*, 1857.

Sismondia polymorpha, *Duncan & Sladen*, var. sufflata: p. 91.

Genus Clypeaster, *Lamarck*, 1801.

Clypeaster apertus, sp. nov.: p. 11.

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Subfamily Echinoneinæ.

Genus Amblypygus, *Agassiz*, 1840.

Amblypygus altus, sp. nov.: p. 16.
—— pentagonalis, sp. nov.: p. 18.

Subfamily Echinolampinæ.

Genus Echinolampas, *Gray*, 1825.

Echinolampas alta, sp. nov.: p. 19.
—— ——, variety: p. 22.
—— Feddeni, sp. nov.: p. 23.
—— Kachensis, sp. nov.: p. 25.
—— Haimei, sp. nov.: p. 26.
—— Damesi, sp. nov.: p. 27.
—— insignis, sp. nov.: p. 29.
—— Vicaryi, *d'Archiac & Haime*: p. 33.
—— sp.: p. 31.
—— sp.: p. 32.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus HEMIASTER, *Desor*, 1847.

Hemiaster decipiens, sp. nov.: p. 34.
—— carinatus, sp. nov.: p. 35.
—— sp.: p. 35.

Genus SCHIZASTER, *Agassiz*, 1836.

Schizaster Baluchistanensis, *d'Archiac*, variety: p. 38.

Genus PERIPNEUSTES, *Cotteau*, 1875.

Peripneustes insignis, sp. nov.: p. 42.

Genus EUSPATANGUS, *Agassiz*, 1847.

Euspatangus affinis, sp. nov.: p. 46.
—— rostratus, *d'Archiac*, p. 47.

List of the Species of Fossil Echinoidea from Strata in the Upper Part of the Nummulitic Series, with Orbitoides in some instances. (OLIGOCENE.)

Order **ECHINOIDEA EXOCYCLICA.**

Suborder GNATHOSTOMATA.

Family CLYPEASTRIDÆ.

Subfamily EUCLYPEASTRIDÆ.

Genus CLYPEASTER, *Lamarck*, 1801.

Clypeaster Sowerbyi, sp. nov.: p. 49.
—— Carteri, sp. nov.: p. 49.
—— Faloriensis, sp. nov.: p. 50.

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Subfamily ECHINOLAMPINÆ

Genus ECHINOLAMPAS, *Gray*, 1825.

Echinolampas, sp.: p. 50.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus EUSPATANGUS, *Agassiz*, 1847.

Euspatangus rostratus, *d'Archiac*: p. 51.

List of the Species of Echinoidea from the Miocene Series of Kachh.

Order **ECHINOIDEA ENDOCYCLICA.**

Family CIDARIDÆ.

Genus CIDARIS, *Klein*, 1734.

Cidaris Halaensis, *d'Archiac & Haime*: p. 51.

Genus GONIOCIDARIS, *Desor*, 1846.

Goniocidaris affinis, sp. nov.: p. 52.

Family ARBACIADÆ.

Genus CŒLOPLEURUS, *Agassiz*, 1840.

Cœlopleurus Forbesi, *d'Archiac & Haime*: p. 53.

Family GLYPHOSTOMATA.

Subfamily TEMNOPLEURIDÆ.

Genus TEMNECHINUS, *Forbes*, 1852.

Temnechinus Rousseaui, *d'Archiac*, sp.: p. 57.
(*Syn.* Temnopleurus Rousseaui, *d'Archiac.*)

Order **ECHINOIDEA EXOCYCLICA.**

Suborder GNATHOSTOMATA.

Family CLYPEASTRIDÆ.

Subfamily EUCLYPEASTRIDÆ.

Genus CLYPEASTER, *Lamarck*, 1801.

Clypeaster depressus, *Sowerby*: p. 58.
—— Waageni, sp. nov.: p. 58.
—— Goirensis, sp. nov.: p. 59.

Genus ECHINODISCUS, *Breynius*, 1732.

Echinodiscus Desori, sp. nov.: p. 60.

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Subfamily ECHINOLAMPINÆ.

Genus ECHINOLAMPAS, *Gray*, 1825.

Echinolampas Indica, sp. nov.: p. 61.
—— Wynnei, sp. nov.: p. 63.
—— sphæroidalis, *d'Archiac*: p. 64.
—— Jacquemonti, *d'Archiac*: p. 64.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus MOIRA, *A. Agassiz*, 1872.

Moira antiqua, sp. nov.: p. 64.

Genus Breynia, *Desor*, 1847.

Breynia carinata, *d'Archiac & Haime*: p. 66.

Genus Troschelia, *Duncan & Sladen*.

Troschelia tuberculata, sp. nov.: p. 67.

Genus Euspatangus, *Agassiz*, 1847.

Euspatangus patellaris, *d'Archiac & Haime*: p. 70.

A Species of unknown Geological Position in Kachh.

Genus Schizaster, *Agassiz*, 1836.

Schizaster Granti, sp. nov.: p. 70.

III. *List of the Species of Echinoidea from the Tertiaries of Kattywar.*
(Miocene Formation.)

Order **ECHINOIDEA ENDOCYCLICA.**

Family CIDARIDÆ.

Genus Cidaris, *Klein*, 1734.

Cidaris depressa, sp. nov.: p. 80.
—— granulata, sp. nov.: p. 80.

Family ARBACIADÆ.

Genus Cœlopleurus, *Agassiz*, 1840.

Cœlopleurus Forbesi, *d'Archiac & Haime*: p. 81.

Family GLYPHOSTOMATA.

Subfamily Triplechinidæ.

Genus Grammechinus, *Duncan & Sladen*.

Grammechinus regularis, sp. nov.: p. 82.

Subfamily Temnopleuridæ.

Genus Temnechinus, *Forbes*, 1852.

Temnechinus costatus, *d'Archiac*, sp.: p. 84.
—— Rousseaui, *d'Archiac*, sp.: p. 84.
—— tuberculosus, *d'Archiac*, sp.: p. 85.
—— affinis, sp. nov.: p. 86.

Order **ECHINOIDEA EXOCYCLICA.**

Suborder GNATHOSTOMATA.

Family CLYPEASTRIDÆ.

Subfamily Euclypeastridæ.

Genus Clypeaster, *Lamarck*, 1801.

Clypeaster depressus, *Sowerby*: p. 90.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus BRISSOPSIS, *Agassiz*, 1840.

Brissopsis, sp.: p. 89.

Genus SCHIZASTER, *Agassiz*, 1836.

Schizaster Granti, *Duncan & Sladen*: p. 88.

Genus BREYNIA, *Desor*, 1847.

Breynia carinata, *d'Archiac & Haime*: p. 90.

Genus EUSPATANGUS, *Agassiz*, 1847.

Euspatangus patellaris, *d'Archiac*: p. 87.

Total species from the Miocene of Kattywar 13
Species common to Kachh and Kattywar 6

List of the Species of Echinoidea from the Tertiary Strata of Kachh.

(NUMMULITIC SERIES.)

1. Arachniopleurus reticulatus, var., *Duncan & Sladen*: p. 11.
2. Sismondia polymorpha, *Duncan & Sladen*, var. sufflata: p. 91.
3. Clypeaster apertus, *Duncan & Sladen*: p. 11.
4. Amblypygus altus, *Duncan & Sladen*: p. 16.
5. —— pentagonalis, *Duncan & Sladen*: p. 18.
6. Echinolampas alta, *Duncan & Sladen*: p. 19.
7. —— —— variety: p. 22.
8. —— Feddeni, *Duncan & Sladen*: p. 23.
9. —— Kachensis, *Duncan & Sladen*: p. 25.
10. —— Haimei, *Duncan & Sladen*: p. 26.
11. —— Damesi, *Duncan & Sladen*: p. 27.
12. —— insignis, *Duncan & Sladen*: p. 29.
13. —— Vicaryi, *d'Archiac & Haime*: p. 33.
14. —— sp.: p. 31.
15. —— sp.: p. 32.
16. Hemiaster decipiens, *Duncan & Sladen*: p. 34.
17. —— carinatus, *Duncan & Sladen*: p. 35.
18. —— sp.: p. 35.
19. Schizaster Baluchistanensis, *d'Archiac*, variety: p. 38.
20. Peripneustes insignis, *Duncan & Sladen*: p. 42.
21. Euspatangus affinis, *Duncan & Sladen*: p. 46.
22. —— rostratus, *d'Archiac*: p. 47.

From beds above the Nummulitic zone and from Strata with Orbitoides.

(OLIGOCENE.)

1. Clypeaster Sowerbyi, *Duncan & Sladen*: p. 49.
2. —— Carteri, *Duncan & Sladen*: p. 49.
3. —— Faloriensis, *Duncan & Sladen*: p. 50.
4. Echinolampas, sp.: p. 50.
5. Euspatangus rostratus, *d'Archiac*: p. 51.

From the Miocene Series.

1. Cidaris Halaensis, *d'Archiac & Haime*: p. 51.
2. Goniocidaris affinis, *Duncan & Sladen*: p. 52.
3. Cœlopleurus Forbesi, *d'Archiac & Haime*: p. 53.
4. Temnechinus Rousseaui, *d'Archiac*: p. 57.
5. Clypeaster depressus, *Sowerby*: p. 58.
6. —— Waageni, *Duncan & Sladen*: p. 58.
7. —— Goirensis, *Duncan & Sladen*: p. 59.
8. Echinodiscus Desori, *Duncan & Sladen*: p. 60.
9. Echinolampas Indica, *Duncan & Sladen*: p. 61.
10. —— Wynnei, *Duncan & Sladen*: p. 63.
11. —— sphæroidalis, *d'Archiac*: p. 64.
12. —— Jacquemonti, *d'Archiac*: p. 64.
13. Moira antiqua, *Duncan & Sladen*: p. 64.
14. Breynia carinata, *d'Archiac & Haime*: p. 66.
15. Troschelia tuberculata, *Duncan & Sladen*: p. 67.
16. Euspatangus patellaris, *d'Archiac & Haime*: p. 70.

Uncertain position.

1. Schizaster Granti, *Duncan & Sladen*: p. 70.

Total species and varieties from the Nummulitic series	22
" " " " Oligocene series	5
" " " " Miocene series	16
" " " of unknown position	1
Total	44
Of these, one form passes from the Nummulitic to the Oligocene	1
One form is from an unknown position	1
	2

Localities whence the Echinoidea were derived.

NUMMULITIC.

Arachniopleurus reticulatus, variety, *Amblypygus altus*, *A. pentagonalis*, *Echinolampas alta* and variety, *E. Feddeni*, *Peripneustes insignis*, *Schizaster Baluchistanensis*, d'Archiac, *Hemiaster decipiens*, and *H. carinatus* were found in a cañon in the Nummulitic rock between Maniara-Fort hill and Karray, about three miles east of Bair.

Echinolampas Haimei, *E. Vicaryi*, d'Archiac & Haime, *Echinolampas* (species of *E. Sindensis* d'Archiac type), and *Clypeaster apertus* came from Nummulitic beds west of Júnagia, north of Ierá.

Echinolampas Damesi, *E. insignis*, *Echinolampas* (species of *E. discus* type), and *Euspatangus affinis* came from a mile east of Goir near Narainsir, from a bed with Pecten and Nummulites; *Echinolampas Kachensis* from near Wagka-padar, upper part of Nummulitic beds; *Euspatangus rostratus*, d'Arch., and *Sismondia polymorpha*, var., came from N.E. of Pipúr.

Upper Nummulitic or Oligocene.

A species of *Echinolampas* distantly allied to *Echinolampas globulus*, Laube, from between Bayow and Didápúr, south-west of Lakpat, Orbitoides group; ***Euspatangus rostratus***, d'Archiac, in beds three or four miles N.N.E. of Pipúr, without Nummulites; and the three species of *Clypeaster* came from the same position.

Miocene.

Cidaris Halaensis, d'Archiac, and *Goniocidaris affinis* came from Warsar north of Jakao; *Temnechinus Rousseaui*, d'Archiac, sp., from north of Akri, south of Bair. *Clypeaster depressus*, Sow., is found east of Goir near Narainsir; river east of Sujapúr; near south bank of the river from Teyra, north of Nalia; south-west of Kotari, &c. The other species of *Clypeaster* from a mile east of Goir; *Echinodiscus Desori* from three miles north-west of Kayari, near Narainsir. *Echinolampas Indica*, *E. Wynnei*, *E. Jacquemonti*, and *Moira antiqua* are from Wamúti; *Echinolampas sphæroidalis*, d'Archiac, from a stream-course near Pipúr, bordering the tidal flats. *Euspatangus patellaris*, d'Archiac and Haime, is from Wahior Stream near Chiropira; the *Breynia* is from Bútta, near Ierá; and *Troschelia tuberculata* is from a stream-course north-west side of Hikelu Hill.

Schizaster Granti, nobis, is most probably from a zone above the Nummulitic beds.

List of the Species of Echinoidea from Kattywar. (Miocene.)

1. Cidaris depressa, *Duncan & Sladen*: p. 80.
2. —— granulata, *Duncan & Sladen*: p. 80.
3. Cœlopleurus Forbesi, *d'Archiac*: p. 81.
4. Grammechinus regularis, *Duncan & Sladen*: p. 82.
5. Temnechinus costatus, *d'Archaic*, sp.: p. 84.
6. —— Rousseaui, *d'Archiac*, sp.: p. 84.
7. —— tuberculosus, *d'Archiac*, sp.: p. 85.
8. —— affinis, *Duncan & Sladen*: p. 86.
9. Clypeaster depressus, *Sow.*: p. 90.
10. Brissopsis, sp.: p. 89.
11. Schizaster Granti, *Duncan & Sladen*: p. 88.
12. Breynia carinata, *d'Archiac*: p. 90.
13. Euspatangus patellaris, *d'Archiac*: p. 87.

Species common to Kachh and Kattywar.

1. Cœlopleurus Forbesi, *d'Archiac*.
2. Temnechinus Rousseaui, *d'Archiac*, sp.
3. Clypeaster depressus, *Sow.*
4. Schizaster Granti, *Duncan & Sladen*.
5. Breynia carinata, *d'Archiac*.
6. Euspatangus patellaris, *d'Archiac*.

Localities of Kattywar Miocene Echinoidea.

Half a mile east of Lowaráli, Oka Mandol; east of Gurgat, Western Kattywar; three miles E. by N. of Gága, and S.E. Gurgat; near Gága, Western Kattywar.

A much-worn specimen of what Sowerby terms *Spatangus elongatus* was found two miles N. of Visáwára, above Porbandar. It is probably a *Brissopsis*.

IV. *Description of the Fossil Echinoidea of the Nummulitic Series of Kachh.*

Order ECHINOIDEA ENDOCYCLICA.

Family GLYPHOSTOMATA.

Subfamily TEMNOPLEURIDÆ.

Genus ARACHNIOPLEURUS, *Duncan & Sladen*, 1882.

A solitary specimen of this genus, which was diagnosed in the "Fossil Echinoidea of Western Sind" (Pal. Indica, series xiv. vol. iii. fasc. 2, p. 42), is in the collection from Kachh. It is evidently a variety of the species *Arachniopleurus reticulatus*, Duncan & Sladen, of Western Sind, from the Ranikot series, found underneath the great development of Khirthar Nummulitic limestone.

1. ARACHNIOPLEURUS RETICULATUS, *Duncan & Sladen*, variety. Plate XI, Fig: 6.

This species was described by us in the "Fossil Echinoidea of Western Sind" (Pal. Ind. ser. xiv. vol. iii. fasc. 2, p. 42, and figured on plate ix. figs. 6, 7, 8).

The variety differs from the type in having vertical ridges between the transverse ridges of the interradia, making the ornamentation more reticulate, and in having two costal ridges placed vertically below the perforate and crenulate tubercles of the interradia.

Locality. From a cañon in Nummulitic rock between Maniara-Fort hill and Karray. Survey-number C 050.

Illustration of the Variety in Plate XI.

Fig. 6. Part of the test: magnified.

Order ECHINOIDEA EXOCYCLICA.

Suborder GNATHOSTOMATA.

Family CLYPEASTRIDÆ.

Subfamily EUCLYPEASTRIDÆ.

Genus CLYPEASTER, *Lamarck*, 1801.

A true *Clypeaster*, with very remarkable ambulacral developments, and possessing the needle-shaped pillars near the edge of the test and between the ambulacra within the test, is in the Nummulitic series of Kachh. Unfortunately the posterior part of the test is absent and the apical system also. The peristome is covered with a very solid mass of Nummulites.

1. CLYPEASTER APERTUS, *Duncan & Sladen.* Plate VI, Figs. 6, 7.

The test is oval-elliptical in marginal outline, very flat beneath, very depressed, with a thin rounded-off edge, and it slopes at first very gradually from the margin to the apical system; but the rise of the test is very slight in relation to its breadth. There is no marginal swelling. Apical system absent. The ambulacra are subequal, and end marginally within one third of the distance from the edge to the apical system. The interporiferous zones are broad and the poriferous are narrow, and instead of approaching distally are wide apart and everted, so as to become more distant at their ends than at a little way within the petal. The pores are subequal, the test is thin, and the needle-pillars are numerous.

Length from front to apical system 45 millim.; greatest breadth 85 millim.; height 17 millim.

Locality. Nummulitic series, west of Júnagia, north of Ierá. Survey-number C 060 A f.

Illustrations of the Species in Plate VI.

Fig. 6. The upper part of the test: natural size.
7. Ornamentation: magnified.

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Subfamily ECHINONEINÆ, Agassiz, 1847.

Genus AMBLYPYGUS, *Agassiz,* 1840.

Amongst the collection of Echinoidea from the Nummulitic strata of Kachh which was obtained by the Geological Survey of India are several fine specimens of the genus *Amblypygus.* The condition of preservation of the specimens is very good, and we are enabled to offer a description of the structural details of their tests, which it is hoped will assist palæontologists to comprehend the well-marked genus better than they have hitherto been able, in consequence of the imperfect condition of most European, African, and American specimens.

Probably the descriptions and illustrations of these forms from Kachh will influence the classificatory position which has hitherto been assigned to the genus *Amblypygus.*

The genus is not represented in the lower Nummulitic series of Sind, called the Ranikot series. On searching amongst the collection of the Echini from the regions of Sind and Kachh, in the Museum of the Geological Society of London, we found a form from Kachh from a Nummulitic horizon at Bábúa Hill, and which was described as *Galerites pulvinatus,* Sowerby, in a memoir by Captain Grant, Trans. Geol. Soc. vol. v. part 2 (read 1857), tab. xxiv, fig. 26.

This specimen has its actinal surface hidden, and therefore nothing but guesses could be employed in attempting its generic position. Desor, in his 'Synopsis des Echinides,' page 321, classifies this form in the genus *Conoclypeus,* and states that it is a large Urchin with a circular outline and hemispherical. The petals are long and open. The length 3½ inches, and the height 1 inch. He considered that it was allied to *Conoclypeus Duboisii,* Agass., of the Crimea and the Bavarian and Swiss Alps.

On comparing this very badly preserved specimen with those which are about to be described, there is no doubt that it belongs to the genus *Amblypygus.* Nevertheless the examination of the form has not been of the least assistance in investigating the anatomy of the test. Desor (*op. cit.* p. 255, tab. xxx, figs. 7–10) gives the generic diagnosis of *Amblypygus* and the essential diagnoses of the species known in 1858.

Agassiz founded the genus in 1840; and the diagnosis is as follows:—"Large Urchins, depressed and circular or ovoid in outline, with thick margins. The petals are largely open and extend to the margin, and they have very narrow poriferous zones. The peristome is central, and more or less angular (many-cornered). There is no floscelle. The periproct is very large and pyriform, and is situated on the inferior surface between the margin and the peristome."

Desor adds in a note:—"At first sight this genus greatly resembles that of *Conoclypeus*, but differs essentially from it in the absence of a floscelle. It is really nearer *Pygaulus* in its alliances, from which it is distinguished by its shape and periproct."

The species noticed by Desor are as follows:—

AMBLYPYGUS APHELES, *Agass.*

Amblypygus apheles, *Agass. Catal. rais.* p. 108, tab. xv, figs. 19, 20.

An elongate depressed form with tumid margins. The petals are very open and the poriferous zones are very narrow. The periproct is elongate and pyriform, and occupies more than half the space between the margin and the peristome. This species is figured by Desor, plate xxx, figs. 7, 8; the figures are reduced one third.

AMBLYPYGUS DILATATUS, *Agass.*

A large species with a circular outline, very depressed. The actinal surface concave and undulating. The periproct is large and elongate.

AMBLYPYGUS ARNOLDI, *Agass.*

A large subcircular form, uniformly tumid, with swollen margins. The petals are very divergent and with very narrow poriferous zones. It is slightly concave actinally. The peristome is small and elongate transversely. One specimen.

AMBLYPYGUS AMERICANUS, *Mich.*

A large circular form with very tumid margins and vaulted upper surface. The poriferous zones are broader than in *Amblypygus Arnoldi*. It is concave beneath, and the peristome is smaller than the periproct, which is large and pyriform.

This diagnosis can be nearly confirmed by examining a specimen in the British Museum, but the shape is depressed and the tumid margins do not pass up to any thing like a conical or vaulted apex. The abactinal surface is comparatively flat, the curvature being very small. There is a gentle slope, equal on all sides, from the highest point to the margin, and there is a slight flatness posteriorly. The tumidity of the margin is remarkable, and the swollen condition reaches only a little on to the actinal surface; for when the test is laid on its abactinal surface, it will be observed that around the peristome, which is slightly in front of the centre, the test rises decidedly, and forms a broad concavity for a considerable space, which even includes the periproct.

The margin is slightly gibbose, and the ambulacra are very faintly projecting above the level of the test. The ambulacra are subequal and the poriferous zones are well developed.

The peristome is oblique, broader than long, and has a greater curve to its posterior than to its anterior margin. The periproct is pyriform, elongate, larger than the peristome, and its anterior end is nearer the peristome than the posterior is to the margin of the test. The distance of the periproct from the posterior margin of the test is equal to half its length.

The dimensions are as follows:—Length 83 millim.; breadth 82 millim.; height 34 millim. The length and breadth may be taken as equal, and the relation of length to height is 1 : 0·409.

The flat and depressed shape resembles that of *Amblypygus dilatatus*, the relation of whose length to height is 1 : 0·43.

De Loriol described *Amblypygus dilatatus*, Agass., in his 'Monographie des Échinides contenus dans les couches Nummulitiques de l'Égypte,' 1881, as follows:—

The shape is circular and as broad as long. The upper part is slightly swollen, uniformly convex, and slightly conical at the apex, which is rather eccentric in front. The actinal surface is tumid ("pulvinée," swollen like a pillow around the impression of one's head) and sunken around the peristome. The margins are rounded and thick.

The apical disk corresponds with the culminating point of the upper surface.

The ambulacra are flush with the test, broad and very long, reaching close to the edge (worn considerably in the specimen). The poriferous zones are relatively broad, equalling about half the breadth of the interporiferous area. The ambulacra continue on to the actinal surface as very small pores, which are in a slight linear depression reaching the peristome. The peristome is very sunken, oblique, tolerably large, and has the shape of an irregular pentagon with very unequal sides. The periproct is not visible. The tubercles (only visible below) are very small, wide apart, and are separated by numerous granules.

The length of the specimen is 72 millim.; the breadth is the same, and the relation of length to height 1 : 0·43

The illustration on plate iii. of his work, fig. 2 *a*, *b*, *c*, is of a specimen whose abactinal surface has been much denuded; moreover the area behind the peristome is missing.

The shape of the peristome is preserved, and it corresponds with that of the species from Kachh.

De Loriol makes some most important remarks on the specimens of this widely distributed species. He asserts that specimens from the Vicentin are nearly as high as the Egyptian form, and that one from Yberg is much flatter. He refers to *Amblypygus apheles*, and does not comprehend Sismonda's figure of it, which has a small pentagonal peristome surrounded by bourrelets. Evidently De Loriol is disinclined to admit the species. With regard to *Amblypygus Arnoldi*, Desor, he says it has a high abactinal surface, a thicker margin, and a less pulvinée actinal surface and smaller peristome than *Amblypygus dilatatus*.

De Loriol has kindly sent us an unpublished work on the Eocene Echinida of Egypt and Lybia, and it contains a notice of *A. dilatatus.* It gives the following measurements:—Length 56 millim.; relative length to breadth as 1 : 0·91; length to height 1 : 0·41. The obliquity of the peristome is admirably shown.

Dr. W. Dames, in his work on the Echinoidea of the Tertiary strata of the Vicentin and Verona ('Palæontographica,' Cassel, 1877, p. 26), briefly but none the less clearly disposes of the species *Amblypygus apheles* from Verona, and states that it is an elongate form of *Amblypygus dilatatus.* He finds that Laube, in his 'Echinid. d. vic. Tert.' p. 20, wrongly attributes *Amblypygus apheles* to a form from the Vicentin, it being *Amblypygus dilatatus*, and he notices that this widely distributed species has not always a sharp margin.

Cotteau, 'Échinides des Pyrénées,' p. 109, gives the generic diagnosis of *Amblypygus*, and adds that the ambulacral pores are oblong and conjugate, that the tubercles are close and homogeneous, and that there is no floscelle.

He named a species *Amblypygus Michelini*; but Leymerie has found that this form has a subpentagonal peristome with a floscelle. Cotteau states that this renders the generic position of the form uncertain, and that it may be a true *Echinolampas.*

The so-called *Amblypygus* from Malta does not belong to the genus.

It appears from these data that the species *Amblypygus apheles* and *Amblypygus Michelini* are worthless. *Amblypygus dilatatus*, Agass., described by De Loriol, is the type of the genus, and the obliquity of the peristome noticed by him becomes therefore a generic character. Desor states that the actinal surface is concave; but it is swollen and convex, except around the peristome, where there is a decided concavity (in the position of the test on its back).

Desor states that *Amblypygus Arnoldi*, Agass., and *Amblypygus Americanus*, Mich. MSS., have the same appearance, and that *A. Arnoldi* is uniformly swollen and has a thick margin; so that, according to our description of *Amblypygus Americanus*, *A. Arnoldi* must be a depressed form, having the relation of length to height as 1 : 0·43. Its poriferous zones are "très étroites."

The form described by Dr. Wright, F.R.S., from Malta, is not an *Amblypygus.*

The species properly included in the genus *Amblypygus* up to the present time are *Amblypygus dilatatus*, Agass., *A. Arnoldi*, and *A. Americanus.*

They belong to a group with specimens having the relation of length to height as 1 : 0·4 and 1 : 0·43.

The chief characteristic of the specimens from Kachh is their great relative height and disposition to a pentagonal outline.

There are three well-preserved specimens, and one which is within 5 millim. of the length of Egyptian *Amblypygus dilatatus* is 10 millim. higher. The relative dimensions are:—Kachh form, length to height 1 : 0·62.

The range of relative length and height in the Kachh forms varies, in perfect specimens, from length 1 : 0·62 to 1 : 0·63.

Moreover, the Kachh forms are longer than broad. Hence it is evident that the Kachh Nummulitic specimens belong to a new species.

1. AMBLYPYGUS ALTUS, *Duncan & Sladen.* Plate IV, Figs. 1–3.

The test is large, very thick, swollen, and subhemispherical above, tumid at the margins and on the actinal surface also. Marginal contour nearly circular. Abactinal surface sloping nearly equally to the front and back. but it is slightly more swollen posteriorly than anteriorly. The lateral slope approaches the curve of a semicircle, but is rather flatter in the upper one third. The posterior interradium is more flattened than the others at the margin. Apical system slightly in front of the centre or central; the system is small in relation to the dimensions of the test, and is pentagonal or irregularly circular in outline. The generative pores are large and stand outside of the irregularly-shaped madreporic body, which separates the posterior ocular plates rather widely.

The anterior ocular plate is distinct, and the pore is well in front of the anterior edges of the antero-lateral generative plates; these are large, and the right one is largely covered by the madreporic, and the left one much less so. The antero-lateral ocular pores are sunken, and their plates are well developed. The postero-lateral generative plates are wide apart, and separated by the low, tumid, madreporic body; their pores are large. The madreporic body has an irregular margin, in no way overlaps the pores, and has its surface covered with close, small, low granules, the intermediate surface being minutely pitted.

The ambulacra are flush with the test, are largely open just above the margin where the poriferous zone alters its character, and become narrower towards the peristome. The poriferous zones of each ambulacrum converge high up in the peristome on its ascending process.

The poriferous zones are well developed abactinally, increase in breadth rather rapidly from the apex, and then diminish more gradually to close above the margin, where the pores are smaller, those of each pair coming nearer together and being more obliquely placed.

The long inner row of pores, circular in outline and well open, forms a nearly straight and diverging linear series; and the outer pores, which are elongate transversely and in the shape of long ellipses, form a curve in vertical series. The pores are conjugate, but the groove is shallow and broad, and usually slightly bent. A low, broad, costal projection is between each succeeding groove, and has on it, where the zone is widest, about 7 distinct granules in a line, with alternate ones smaller than the others. Near the margin the pores of each pair are not on the same level, the inner one being the lowest down; and on the margin this obliquity becomes very decided, the outer pore being nearly above the inner one, and separated by a narrow and linear bridge. The pairs increase in number at the margin and over it, and become fewer near the peristome, where they again become less oblique. The pores pass up within the peristome on its vertical walls and end close to their free edge. There is no phyllode. Every third pair of pores is in the centre of a small accessory plate. The anterior odd ambulacrum has a curved course actinally, and is not placed there in a line with the longitudinal axis of the test.

The interporiferous zones are narrow in the upper part of the test where the poriferous zones are at their broadest. There the poriferous zone is only slightly narrower than the interporiferous area. The breadth of the interporiferous zone increases towards the margin.

The ornamentation of the interporiferous zones is scanty, small, and distant down to near the margin, where it becomes larger and closer; on the edge of the actinal surface it is still larger, and near the peristome larger still and not so close. It consists of low tubercles, with small perforate mamelons and crenulate bosses (usually worn off) standing in barely sunken or flat scrobicules, which are wide and are encircled by a row of distinct granules sharp at the top, and resembling the largest of those seen on the costæ between the grooves of the poriferous zone. The circles of granules may or may not interfere with each other. The ambulacra are wide apart, equidistant, and the extreme breadth is from 14–15 millim.

The interradia are wide, and the ornamentation, of the same kind as that of the interporiferous zones, is scanty abactinally, closer at the margin, and largest and closest near the peristome. Actinally there is more space in the interradia near the peristome in the 1st and 3rd areas than in the others; and consequently the 2nd and 3rd, and 4th and 5th ambulacra are closer together at the peristome than the 1st and 2nd, and 3rd and 4th (Lovén's enumeration).

The peristome is subcentral, sunken, very large, and its longest diameter, obliquely placed, is between the right antero-lateral and left postero-lateral interradial spaces (between areas 2 and 4). It is deep, widely open, and has a precipitous inner wall. The shape is irregular, a lesser anterior curve being opposed to a larger and posterior one; where the extremities of the curves meet at the ends of the long diameter are blunt angles. A close and larger than ordinary tuberculation covers the sides of the peristome; and the length of the long diameter is 18 millim. in large and 14 in smaller specimens, and the length of the short diameter is 11 millim. and 6 millim. respectively.

The periproct is large, pear-shaped, situated longitudinally, bluntly angular in front, broadest near its posterior end, which is close to the margin. The periproct is slightly longer than the long diameter of the peristome. The distance of the anterior angle of the periproct from the posterior edge of the peristome is rather more than one half of the length of the periproct itself.

In a perfectly uninjured specimen the test rests on the tumid actinal surface, not very distant from the edge of the peristome, the whole of the tumid margins being above the resting-plane.

The plates of the ambulacra near the peristome are larger than further out, and the pairs of pores perforate them; every third pair perforate a small accessory plate placed near the interradium.

The arrangement of the interradial plates at the peristomial edge is as in *Echinoneus*. There is a single broad plate in areas 1, 3, 5, and there are two plates in areas 2 and 4.

Locality. Kachh. Nummulitic beds in white limestone. Survey-numbers

C 050 A f and C 050. From a cañon in Nummulitic rock between Maniara-Fort hill and Karray.

Illustrations of the Species in Plate IV.

Fig. 1. A large specimen, side view: natural size.
2. The same, abactinal view: natural size.
3. The same, actinal view: natural size.

2. Amblypygus pentagonalis, *Duncan & Sladen.* Plate IV, Figs. 4–11.

The test is pentangular in marginal outline, especially in young forms; it is longer than broad and broader than high, broadest at the distal ends of the antero-lateral ambulacra, tumid at the ambitus, curving boldly to the apex, which is rather behind the centre, and more precipitously from it to the posterior edge. The profile seen from the front is nearly hemispherical. The actinal surface is tumid; the peristome is oblique, deeply seated and large; and the long, nearly elliptical periproct is large, and reaches from the margin to three fourths of its length from the peristome.

Length of a test 85 millim., breadth 77 millim., height 53 millim.; relative length to breadth 1 : 0·9, length to height 1 : 0·62.

A smaller specimen is 78 millim. long, 72 millim. broad, and 45 millim. high; relative length to breadth 1 : 0·92, length to height 1 : 0·57.

The ambulacra are slightly raised above the level of the interradia, and add to the pentangular appearance; they are widely open at the margin and become narrower where the normal poriferous zone merges into the series of double pores. The peristome is rather straight at its anterior edge, and rather angular posteriorly, the indefinite apex of the triangle being at the entrance of the right posterior ambulacrum (No. I.) into the peristome.

Locality. The same as *Amblypygus altus*, in the Nummulitic series of Kachh. Survey-numbers C 050, C 050 A t, C 050 A.

Illustrations of the Species in Plate IV.

Fig. 4. The test, side view.
5. Abactinal view of the test.
6. The peristome and part of the periproct.
7. Ornamentation of the margin: magnified.
8. Ornamentation, abactinal: magnified.
9. Part of an ambulacrum, poriferous and interporiferous zones: magnified.
10. Termination of normal poriferous zone in the double series of pores, and part of an interporiferous zone.
11. Apical system: magnified.

This species differs from *Amblypygus altus* in its shape, the projection of the ambulacra, and in the more elliptical periproct and triangular peristome. The ornamentation and details are nearly the same, however; and were there not abundance of specimens of both kinds we should feel the difficulty of making this angular form any thing more than a racial variety; but it is a distinct species.

The nature of the ambulacra, their continuous series of double pores, the intercalated poriferous plates, the oblique peristome, and the position of the periproct ally *Amblypygus* to *Echinoneus*, which is its modern representative. The genus *Amblypygus* belongs to the subfamily Echinoneinæ.

Subfamily ECHINOLAMPINÆ.

Genus ECHINOLAMPAS, *Gray*, 1825.

The species of this genus from the Nummulitic of Kachh are as peculiar as those described by de Loriol from Egypt*. Most of them are very tall and large, and look like *Conoclypei*, but they have all the generic characters of *Echinolampas*. The identity of any species from Kachh with any one of those so admirably described by de Loriol cannot be asserted; but the alliances are close, and the mimeticism of the two faunas as regards this genus is very remarkable.

1. Echinolampas alta, *Duncan & Sladen.* Plate I, Figs. 1–6.

The test is thick, large, high, helmet-shaped, with steep sides; it is longer than broad, and slightly broader than high. The highest point is central and behind the apical system, which is slightly excentric in front, or at $\frac{4}{10}$ of the distance from the anterior to the posterior edge. The test slopes rapidly to the front, and is almost vertical near the ambitus; the slope is bolder and with a greater curve posteriorly, where it includes the produced and subrostrated posterior interradium. The direction is very vertical near the margin posteriorly and laterally. Seen from the front, the outline is almost hemispherical above and vertical on either side nearly to the margin.

The actinal surface is oval elliptical in outline, longer than broad, rounded in front, less rounded and broadest on a line with the peristome, and narrower and slightly pinched-in on either side of the rounded posterior part. The margins are rounded off; they are sharpest on a line which passes through the peristome transversely, and also on either side of the periproct. The peristome is slightly sunken, and the whole actinal surface is slightly concave from before backwards, so that the test rests fore and aft, and does not touch the surface which corresponds with the transverse line above mentioned. There is a sensible swelling of the margin anterior to the lateral ambulacra, and it is less, and more dependent in front of the postero-lateral. The test rests upon a faintly swollen surface within the margin.

The interradial areas, more or less vertical and evenly curved above the margin, are tumid high up, and the posterior, more swollen than the others near the apical disk, is produced with a decided latitudinal curvature to form a well-developed projection nipped-in on either side. The ambulacra, flush with the test near the margin, are slightly sunken above in consequence of the tumidity of the interradia.

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* *Op. cit.* p. 88 (32). See *suprà*, p. 14.

The apical system is on the anterior slope of the test, is in a very slight depression, is circular in outline, and is flat button-shaped. There are four large generative pores; the front pair are closer than the others, and all are at the edge of the disk, which is granular and mainly consists of madreporiform body. The ocular pores are small and are covered by the edge of the disk.

The ambulacra are long, reaching close to the margin, widely open, unequal; and whilst the odd and antero-lateral are straight, the postero-lateral have a slight curvature.

The poriferous zones are well developed and are very slightly sunken below the level of the interporiferous areas; the inner lines of pores are in long, straight, diverging lines, so that the interporiferous areas show no tendency to close, and they gradually increase in width from the apex to close to the margin. The poriferous zones are broadest from a third to about halfway down, and they diminish in breadth gradually to a point, and are of unequal length—the right zone of the odd ambulacrum, the anterior zone of the antero-lateral, and the posterior zone of the postero-lateral ambulacra being shorter than their fellows by a very few pores. Moreover the antero-lateral poriferous zones slope slightly backwards near the margin. The pores are conjugate, the groove being well developed; and the inner pores are elliptical and the outer elongate in outline. There is often a faint curvature of the conjugating grooves. There is a well-developed costal ridge between each pair of grooves, and it is ornamented with a single row of large granules, which are sometimes separated by much smaller ones or by a space. Towards the margin the poriferous zones become narrower and the pores closer together, until at last a simple narrow groove only contains one pore. In the postero-lateral ambulacra, about halfway up the test, there are nine ambulacral plates to one interradial plate. The ambulacra do not come to a point at the apex, and there is a little breadth there.

The interporiferous zones, narrow at the apex, increase very gradually in breadth to their termination near the margin. Slightly above the level of the poriferous zones they are nearly flat, and are ornamented with small sunken tubercles which are mammillate, crenulate, and perforate, and which are separated by narrow tumid ridges minutely but sharply granular. Below the margin of the test the poriferous zone is continued over the actinal surface, one row of pores existing for about two thirds of the distance to the peristome, and the pores are close, denoting a considerable number of ambulacral plates. The rows of pores are in exceedingly faint grooves, which gradually approximate until the open and somewhat rudimentary phyllode is reached. The interporiferous zones become narrow from the margin to the peristome, are rather tumid from side to side, and are decidedly below the level (in the normal position of the test) of the pores in their grooves. Towards the peristome the pores, which are small and surrounded by minute cavities, and are elongate (their long axis being on a line with the direction of the ambulacra), become more numerous, two and three rows existing. The rows are placed obliquely; and it appears that in some instances there are extra plates. Traces of pits occur near the peristome between the lines of pores; and each ambulacrum ends in two large pores, which are well within the peristomial margin.

The interporiferous zones actinally have a slightly larger ornamentation than abactinally, but of the same kind; they narrow near the peristome, and become gutter-shaped more or less, owing to the tumidity of the bourrelets.

Actinally the interradia are well developed, and they form a considerable part of the peristomial margin, where they are slightly tumid, project, and bound the transversely elongate pentagonal aperture. The bourrelets of the lateral interradials are the smallest, the others being larger, broader, and more projecting and subequal. The ornamentation of the actinal part of the interradials increases in size from the margin to close to the peristome, where it again becomes crowded and covers closely the bourrelets and their ascending processes within the peristome. A trace of wearing occurs in the median line towards the periproct.

The peristome is large, pentagonal, transverse, subcentral, is on a higher plane than the margins in front and behind, and nearly on a level with the margin posteriorly to the antero-lateral ambulacra. It is deep, and bounded by a vertical tube-like process of the test formed mainly by the interradia. The depth is at least 6 millim. There are no auricles or teeth.

The periproct is large, transversely elliptical, rather larger than the peristome, close to the posterior edge of the test within the margin, and occasionally transgresses on it; it looks downwards and a little backwards. The large ornamentation of the actinal surface of the posterior interradium becomes smaller and closer around the periproct.

Abactinally the distinct and rather wideapart interradial ornamentation resembles in details and point of size that of the ambulacra; but the tubercles become crowded and smaller near the margin, and actinally the crowding persists, the tubercles being larger also.

The length of the test is 89 millim., and the greatest breadth is 70 millim.; the height is 67 millim.; so that the proportional measurements are—length 1, breadth 0·786, height 0·75.

Locality. Kachh. From a cañon in Nummulitic rock between Maniara-Fort hill and Karray, about three miles east of Bair. Survey-number C 050.

Illustrations of the Species in Plate I.

Fig. 1. *Echinolampas alta*, Duncan & Sladen. Side view: natural size.
2. Actinal view: natural size.
3. Apical system: magnified twice.
4. Peristome: magnified.
5. The antero-lateral ambulacrum, near the margin: magnified.
6. Ornamentation of ambulacrum: magnified.

2. Echinolampas alta, *Duncan & Sladen*, variety. Plate I, Fig. 7.

Many specimens of this species are in the collection, and there appears to be but slight variation in them in spite of differences of size. The main distinction (which, however, is only slight) is that in some forms the test is less oval in actinal outline and approaches an ellipse with one end more rounded than the other. This is produced by a slight enlargement of the test close in front of the postero-lateral ambulacra (Plate I, fig. 7). Again, the type has tumid interradials abactinally; another form is less tumid; and a third, that represented in Plate I, fig. 7, is barely tumid. We feel disposed to admit this last as a variety, and to characterize it by the deficient tumidity of the interradials abactinally, the more ellipsoid shape actinally, and the comparative shortness of the ambulacra. It is from the same locality as the type.

Illustration of the Variety in Plate I.

Fig. 7. *Echinolampas alta*, Duncan & Sladen. Variety.
Actinal surface: natural size.

A large specimen, which has been crushed somewhat from above downwards, is from the same locality. It shows a slightly more prominent condition of the interporiferous zones than the type. The curve of the postero-lateral ambulacra is greater, and the shape of the base is broader. There is no doubt about the single row of granules separated by smaller ones or by spaces on the costæ of the poriferous zones, and that the ornamentation of the test consists of sunken tubercles with mamelons and crenulations, the intermediate areas being largely granular.

One specimen is remarkable for its height, yet the specific distinction of a greater breadth than height prevails. The dimensions are: length 84 millim., breadth 67 millim., and height 64 millim. This is the greatest deviation in point of greater height from the type. Relative length to height 1 to 0·76. Survey-number C 050 B f.

Another, and larger, specimen has the following dimensions:—length 90 millim., breadth 70 millim., and height 64 millim.; length to height 0·71. Survey-number C 050.

This remarkable Echinolampad is common, and at once strikes the eye on account of its height, tumid interradia near the apex, the slant behind, the vertical sides, and the long gradually enlarging ambulacra.

It resembles a *Conoclypeus* in shape and ornamentation. There is no species like it in the Tertiaries of Sind; but de Loriol's monographs of the Nummulitic deposits of Egypt contain admirable descriptions and figures of very closely allied forms.

Echinolampas Fraasi, P. de Loriol*, is closely allied; and it is to the group of which that fine African species is a type that the form from Kachh belongs—tall Echinolampads, with long, not very unequal, and not petaloid distally ambulacra.

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* "Monographie des Échinides nummulitiques de l'Egypte," Mém. Soc. de phys. et d'hist. nat. de Genève, t. 27, i. p. 92, pl. v. fig. 1. "Eocäne Echinoideen aus Aegypten und der Libyschen Wüste," Palæontographica, N. F. x. 1. (xxx.). p. 22, pl. vi. figs. 1, 1 *a*, 1 *b*.

The dimensions of the Kachh species and *Echinolampas Fraasi* are as follows:—

	Kachh.		*E. Fraasi.*	
	millim.	millim.	millim.	millim.
Length	89	84	86	92
Length to breadth is	1 : 0·78	0·8	0·84	0·84
Length to height .	1 : 0·75	0·76	0·68	0·67 : 0·68

The height of the species from Kachh is in excess, and it is narrower than *Echinolampas Fraasi*.

The interporiferous zone is broader in the African form, in which, moreover, there is a tendency to closing of the ambulacra. The anterior part of the test slopes differently in the two species, and the basal level differs. The alliance is very close, and the species are representative.

3. ECHINOLAMPAS FEDDENI, *Duncan & Sladen*. Plate I, Figs. 8–11; Plate III, Fig. 2.

The test is tall, subhelmet-shaped, longer than broad and broader than high; roundly oval actinally, and rounded at the margins, so that it stands on a smaller area than the ambitus.

The abactinal surface curves gradually to the apex, which is slightly excentric in front and a little anterior to the highest point of the test. The slope in front is sharp and precipitous, and that behind is more gradual, and the anterior profile is hemispherical, with a flatness about the flanks.

The actinal surface is rounded in front, and more broadly so behind; is well curved at the sides also. It is tumid anteriorly to the subcentral peristome, faintly projecting and subkeeled between the peristome and the submarginal transverse periproct, and concave on a line with the sides of the peristome. The margins are well rounded and form no sharp angles, and the most dependent portions of the test on which it rests are in front of the peristome and between it and the periproct.

The apical system is small, and there are four large generative pores and a depression over the position of the fifth. The front pair are closer together than the posterior; and the madreporiform body is central and large. The ocular plates and pores are very small.

The ambulacra are subequal in length and breadth; the interporiferous zones are slightly above the level of the test, except near the apex, where some tumidity of the interradials occurs; and the poriferous zones, unequal in length in the same ambulacrum. are either very slightly sunken or oblique. The ambulacra reach near to the margin, but are separated from the lowest point of it by a sensible space; they are widely open, and show only the faintest approach to closure. The poriferous zones at their broadest part are much narrower than the interporiferous areas there, and these last have a faint longitudinal groove. The anterior odd ambulacrum is straight, increases in width to midway to the margin, and then remains of the same dimensions until lower down, where there is a very slight narrowing of the interporiferous zone and a decided diminution in breadth of the poriferous zones. The poriferous zones are narrow; about 2½ their breadth would equal that of the interporiferous at the widest part; the inner pores are circular and large; and the outer, elongate elliptical, are equal to or even slightly larger than the others; a broad and deep groove connects them; and the costæ between the pores are stout, rounded above, where there is a row of distinct granules. The direction of the costæ and grooves is rather oblique. The breadth of the zone diminishes marginally, but there is only a slight difference in the respective zone-lengths. The ornamentation of the interporiferous zone is of numerous sunken tubercles in scrobicules rather more than their own width apart. The tubercles are slightly mammillated and crenulate, and the interscrobicular areas are rather tumid and sharply and distinctly granular.

The antero-lateral ambulacra form a very wide angle, have the posterior poriferous zones more bowed than the anterior, and there are a few more pairs of pores in the anterior than in the posterior zone.

The postero-lateral ambulacra are sinuous, and the anterior poriferous zone is slightly the longest. The poriferous zones are continued in all the ambulacra over the margin to close to the peristome as a single series of pores.

The interradial areas abactinally are very faintly tumid near the apex, have a distinct median sutural line, and there is a slight flattening of the posterior interradium, with two indistinct keels running down to the margin to end on either side of the periproct.

The ornamentation is equal from just above the margin to the apex, and consists of the same structural details as seen in the interporiferous ambulacral areas. The granulation, however, is distinct and large, but scanty. Near the margin the scrobicules become much closer, and thence to the peristome the ornamentation is less crowded, but more so than above. Near the periproct it is crowded, and especially at the posterior margin, where it is smaller than elsewhere. Between the periproct and the peristome is a worn surface.

The peristome is subcentral, and not quite beneath the apical system in some and beneath it in others. It is large, widely open, elongate transversely, pentagonal, and the bourrelet of the posterior interradium is low and the broadest; those of the anterior interradial areas are slightly tumid and project, and are larger than those of the lateral areas. A minute tuberculation covers the ingoing process from the peristome; and the rudimentary phyllodes are in very shallow grooves. There is a well-developed row of outer pores in each phyllode and a few inner ones, but they are between the plates on the sutural lines. The usual pair of pores is at the commencement of each phyllode within the peristome; and there are numerous pits in the position of sphæridia.

The periproct is larger than the peristome, is elongate transversely, and irregularly elliptical, the posterior curve being less than the anterior. It is inframarginal, and not visible from behind.

The height of the type is 44 millim., the breadth 58 millim., and the length 62 millim.; and these dimensions give the relation of length to breadth 1 : 0·95, height 1 : 0·709.

It follows that the relative dimensions of this form are not very diverse from those of the species just described (*Echinolampas alta*).

But the present species is not a young form of the last; and the narrow poriferous zones, the sinuous postero-lateral ambulacra, the tumid free peristomial region, the faint posterior keel, and the general roundness of actinal contour cause it to differ specifically from *E. alta*.

Locality. Kachh. Nummulitic series; from the same geological horizon as *Echinolampas alta*. Survey-number C 050.

Illustrations of the Species in Plate I.

Fig. 8. The test, side view: natural size.
9. Abactinal view: natural size.
10. Part of an ambulacrum: magnified.
11. A postero-lateral ambulacrum: magnified.

Illustration of the Species in Plate III.

Fig. 2. Actinal view: natural size.

There are several specimens of this form in the collection, and they present considerable variation. In one form with the Survey-mark C 050 f (B) the greatest breadth is behind the peristome, the apical system is more central, and there is a more evident tendency on the part of the ambulacra to close. In another, which is slightly taller than the type, the more central apical system is seen, and the top of the test is less rounded.

This species is also a representative of the tall African Nummulitic Echinolampads; and the resemblance of the actinal area to that of *Echinolampas Fraasi*, de Loriol, is remarkable. The specific distinctions are in the relative heights and the shape of the posterior ambulacra, and the difference in the anterior slope of the test, together with the remarkably uneven base of the Kachh species.

4. ECHINOLAMPAS KACHENSIS, *Duncan & Sladen*. Plate II, Figs. 1–4.

The test is tumid above, broadly elliptical in marginal outline, longer than broad and broader than high. Length of specimen 53 millim., relative length to breadth 1 : 0·9, and length to height 1 : 0·6. It is almost hemispherical in its profile seen from the front. The highest point is at the apical system, very slightly excentric in front, and the posterior slope is bolder than the greatly curved anterior. The margins are rounded off but not tumid, and the posterior part is flat and in relation to the inframarginal periproct. The position of the peristome is very slightly in the rear of a vertical line leading upwards to the apical system. The apical system has four generative pores and a central madreporic body. The ambulacra are flush with the test, rather unequal in breadth, the posterior being the broadest and longest. The poriferous zones are narrow, and the interporiferous are broad, one being 2½ times the width of a poriferous zone.

The ambulacra are open, and the anterior shows no tendency to close, but all have the distal ends of the perfect poriferous zones diminished in breadth. This is very decided in the postero-lateral, and less so in the odd ambulacrum. The outer pores, elongate elliptical, are larger than the inner and nearly circular pores, the grooves between them are broad, and the costæ are stout and placed rather obliquely. Coming nearly to points, the poriferous zones of the odd ambulacrum are slightly unequal. The posterior poriferous zone of the antero-lateral ambulacra has five or six pairs of pores more than the anterior zone, which is less curved than the other, and yet both tend (although the space between them is narrowed) to turn slightly away from one another. The postero-lateral ambulacra are sinuous, and the poriferous zones come rather close together at the end, the anterior being the longest. All the perfect zones stop well short of the margin of the test, and a single series of pores passes over to the actinal surface. The interradial areas are large from the great angle formed by the antero-lateral ambulacra; they are not tumid, and the posterior one is decidedly flattened near the margin.

The interporiferous areas and the poriferous zones are very nearly flush with the test.

The ornamentation of the interporiferous areas and of the interradials above the ambitus is identical, and consists of equal-sized tubercles in sunken scrobicules, which are separated by granular spaces.

The actinal surface is tumid between the front and the peristome, and is less so between this and the periproct. The test touches at these tumid points and not on a line which passes transversely through the peristome, which is very slightly sunken. The peristome is pentangular, longest transversely, and has small low bourrelets and rudimentary phyllodes, consisting of a number of outer pores and a few inner ones.

The periproct is close to the sharp edge, is inframarginal, larger than the peristome; is elliptical, with narrow ends, and is elongate transversely. Actinally the ornamentation is slightly larger and more crowded.

Length of the specimen 53 millim., height 32 millim., breadth 48 millim.

Locality. Kachh. Near Wagka-padar, upper part of Nummulitic beds. Survey-number C 057 f.

Illustrations of the Species in Plate II.

Fig. 1. *Echinolampas Kachensis*, side view: natural size.
2. Abactinal view: natural size.
3. Actinal view: natural size.
4. Part of an ambulacrum: magnified.

5. Echinolampas Haimei, *Duncan & Sladen.* Plate II, Figs. 6, 7, 8.

The test is depressed, longer than broad and broader than high, rather conical above, with the sides sloping without much curvature to the tumid margin, which has an oval elliptical actinal outline, the greatest breadth and boldest curve being posterior to the peristome. Relative length to breadth 1 : 0·87 to height 1 : 0·42. The apical system is slightly anterior, and is at the highest point of the conical part of the test, and the posterior slope is bolder than the anterior. The generative pores are large and oblique.

The ambulacra are flush with the test, are unequal, do not reach the margin, are petaloid more or less, but the anterior shows but little tendency to close as the others do. The postero-lateral are the longest and the broadest, whilst the odd ambulacrum and the antero-lateral are abont the same length, the latter being the broader. The interporiferous zones are broad, more than twice as broad as a poriferous area. The anterior poriferous zone of the antero-lateral ambulacrum is shorter than the posterior, towards which its end curves. The zones of the other ambulacra are equal in length.

The outer row of pores is larger than the inner. The actinal surface is slightly tumid; and the peristome, which is small, slightly excentric in front, is rather sunken. It is pentagonal, and the bourrelets are feebly developed and are very flat; the anterior nearly equal the posterior one, and the postero-lateral are the narrowest. The sides of the peristome are very precipitous, and are ornamented with small close tubercles. The phyllodes are moderately developed; there are two pores within the peristome on each, and beyond them is some doubling of pores; those of the normal single row are placed at the junction of sutures near the peristome, but further out they appear to penetrate the ambulacral plates; but this is produced by wearing and the obliquity of the canal. There is one plate to each interradium at the peristome.

Length of test 54 millim. when perfect, breadth 47 millim., height 23 millim.

Locality. Kachh. Nummulitic series, and west of Júnagia, north of Ierá. Survey-number C 060 A f.

Illustrations of the Species in Plate II.

Fig. 6. The abactinal part of the test: natural size.
7. The actinal surface: natural size.
8. A part of a phyllode: magnified.

6. Echinolampas Damesi, *Duncan & Sladen.* Plate II, Figs. 9, 10; and Plate III, Fig. 1.

The test is rather depressed, slightly longer than broad, and the height is less than half the length; it is subhemispherical above and broadest behind. The relative dimensions are—length to breadth 1 : 0·92, and length to height 1 : 0·42.

In marginal outline the test is subcircular, and is broadest just behind the median lines of the postero-lateral interradia, where there is a slight projection at the margin. The front of the marginal outline is rounded, and behind the point of greatest breadth it is more broadly rounded, but posteriorly it becomes slightly flattened at the spot corresponding with the periproct. The highest point of the test is central, and there is a sharper slope forwards than backwards. The margin is boldly curved and tumid in front, and the tumidity diminishes behind the antero-lateral ambulacra, where the test is rather sharply rounded; and this condition persists to the neighbourhood of the periproct.

The apex is rather excentric in front, being 9 millim. in front of the centre, the extreme length of the test being 77 millim.; and the result is to give a comparatively narrow anterior part and a long and broad posterior portion. The sunken peristome is excentric in front and under the apical system, and is surrounded by the tumid actinal surface; and the test rests on a surface between the peristome and the ambitus. There is slight flattening between the peristome and the periproct.

The apical system is small, the disk is round, and the ocular pores hidden.

The ambulacra, unequal in length, are on the whole narrow, and nearly flush with the test; the antero-lateral ambulacra curve slightly, concavity in front, are very wide apart, and tend decidedly to close; but the anterior poriferous zone is shorter than the other, and curves slightly backwards at its termination. The posterior zone is curved with the concavity forwards, and near the margin it ends with a slight curve in the opposite direction. The zones are narrow and about one half of the breadth of the interporiferous areas where best developed. The inner series of pores are circular in outline, and the outer are larger and elongate-elliptical; they are conjugate, the groove being slightly oblique, and the costæ, which are well developed, have a row of granules.

The postero-lateral ambulacra form an angle of about 70°, are straight, slightly broader in the interporiferous zone than the anterior, reach far towards the margin, but not more so than the antero-lateral, are widely open, and there is one pair of pores in excess in the anterior zone. The poriferous zones are slightly narrower than those of the antero-lateral ambulacra, and the conjugating grooves are more oblique.

The postero-lateral interradia are slightly gibbose at the margin, and the posterior interradium is flattened behind the periproct.

The peristome is large, broad, pentagonal, with the nearly flat bourrelets subequal in the antero-lateral and posterior interradia, and narrowest in the postero-lateral regions. The pores are sunken in round pits, and the reduplication is scanty. The walls of the peristome pass up and form a pentagonal tubular process with the angles rounded.

The periproct, broader than long, has a slightly curved posterior and a more boldly curved anterior margin, and the junction of the margins is by acute lateral angles. A mere ridge separates it from the posterior surface of the test.

The ornamentation is generally close, and is larger actinally than abactinally; that of the interporiferous zones is similar to that of the interradia. It consists abactinally of small depressed tubercles with small pointed mamelons, both crenulate and perforate, standing in shallow circular scrobicules which are separated by a slightly raised surface crowded with distinct and sharp granules. Just under the ambitus the crowded ornamentation is the smallest, and the largest kind is found on the bourrelets and on the posterior interradium near the peristome. Near the periproct the ornamentation is small, and especially posteriorly to it on the ridge.

Length of the test 77 millim., breadth 71 millim., height 33 millim. Apical disk 9 millim. in front of centre. Breadth of peristome 11 millim., and breadth of periproct 13 millim.

Locality. Kachh. Nummulitic series. One mile east of Goir, near Narainsir; from bed with *Pecten* and Nummulites. Survey-number C 043 B f.

Illustrations of the Species in Plate II.

Fig. 9. The test, abactinal surface: natural size.
10. The ornamentation: magnified.

Plate III.

Fig. 1. The actinal surface: natural size.

The dimensions of this form in height, breadth, and length somewhat resemble those of *Echinolampas discoideus*, d'Archiac and Haime, from the Nummulitic of Sind. The differences in structure are the more tumid posterior part of *E. discoideus* and its want of any marginal tuberosity; and the tumid nature of the actinal surface around the peristome of the new form constitutes a decided distinction. It has also a larger periproct, that of *E. discoideus* being small.

The new form has not the lateral symmetry or the small peristome of *Echinolampas discus*, which is altogther more circular in outline. It is distinct from, but representative of, *Echinolampas Osiris*, Desor, sp., from Egypt.

7. ECHINOLAMPAS INSIGNIS, *Duncan & Sladen.* Plate III, Figs. 3–6.

The test is large, almost circular in actinal outline, conical above, flat in anterior slope, nearly as broad as long, and about one half as high as broad. The relative proportions are—length as to breadth 1 : 0·966, and length as to height 1 : 0·488.

The apical system is at the highest point of the test, and is about 3 millim. in front of the centre. The test slopes with a gentle curve on either side of the apex to the tumid margin, and has a decided flattish slope in front, which contrasts with the gentle posterior curve of the test. The margins are tumid or rounded, and most so in front and behind the periproct, where there is some flatness. The test reposes on the rather convex actinal surface within the limits of the margin. The peristome, 11 or 12 millim. broad, is sunken, large, much broader than long, and has the posterior bourrelet the broadest, and the postero-lateral very small; the antero-lateral are the most tumid, but all are slightly developed. The periproct is large, elliptical, with a greater anterior than posterior curvature; it is broader than the peristome, and is close to the posterior part of the test and inframarginal. The test is less convex between the periproct and peristome than elsewhere actinally.

The apical system is large, circular in outline, a little tumid centrally, but sunken round the edge; and the greater part is occupied by the madreporic body, which is covered with nodular granules. There are four generative pores, which are large, and the anterior pair are closer than the posterior. The ocular plates are very small.

The ambulacra are unequal, moderately broad, the posterior being the longest and the others subequal; the odd ambulacrum is slightly narrower and shorter than the others, and all pass far towards the margin, but none of the petaloid parts reach it. The odd ambulacrum is widely open at its marginal end, but still the poriferous zones converge there slightly; the antero-lateral tend to close, but do not, and this is observed in a less degree in the postero-lateral ambulacra. The interporiferous zones are broad, slightly convex, and raised above the level of the rather sunken poriferous zones. The posterior ambulacra have the broadest interporiferous zone, and all are ornamented with a close small tuberculation in small sunken scrobicules, the intervening part being finely, sparely, and distinctly granular. The tubercles are barely above the test, and have small mamelons.

The poriferous zones are broad, the pairs are obliquely placed, and the pores are large and conjugate. The pairs are separated by well-developed granular costæ. The pores of the outer row are elongate-comma shaped, and the inner pores are nearly circular.

The poriferous zones of the anterior odd ambulacrum, slightly petaloid in their contour near the apex, diverge gradually to their ends; the inner lines of pores are nearly in straight series, and the outer form curves on account of the breadth of the poriferous zones increasing gradually to one half of their length and then diminishing to a point.

The antero-lateral ambulacra form a widely open angle of 170°; are at first narrow and petaloid, then are enlarged in breadth, and they become gradually narrower to their end above the margin. The anterior poriferous zone is the shortest, and is nearly straight in its direction from the apex to some distance from the margin; and the posterior zone is decidedly curved, with the convexity posterior. Towards the end of the posterior zone the pairs of pores diminish in breadth and turn slightly backwards.

The interporiferous zone of the posterior ambulacra is wider than that of the other ambulacra; and the poriferous zones are slightly unequal, the anterior being the longest. The anterior zone is more curved than the posterior, which is nearly straight in comparison, and there is a tendency to close.

The interradia are large, the anterior are singularly flat abactinally, and the posterior one has no unusual convexity. The ambulacra are continued over the margin in single series; and there is a phyllode in a narrowing groove corresponding with each one.

The pores are doubled near the peristome; they are in depressions which resemble scrobicules without tubercles.

The ornamentation of the abactinal part of the test generally resembles that of the interporiferous zones; it becomes closer and smaller at the margins, and increases in size and is wider apart and largest near the peristome. It is especially large on the bourrelets, a little way off the peristome.

Length of specimens 90 and 83 millim. Relation of length to breadth 1 : 0·966 and 1 : 0·987 ; and of length to height 1 : 0·488 and 1 : 0·47.

Locality. Kachh. One mile east of Goir, near Narainsir. Nummulitic series. Survey-number C 043 B.

The specimen measuring 83 millim. in length (Survey-number C 043 f B) is of course smaller than the type, and its peristome is more elongate transversely and less pentagonal.

Illustrations of the Species in Plate III.

Fig. 3. Abactinal view : natural size.
4. The test, side view : natural size.
5. Actinal view : natural size.
6. Part of an ambulacrum : magnified.

8. ECHINOLAMPAS, sp.

Two much injured specimens of an *Echinolampas*, with a circular marginal contour, are amongst the collection from Kachh, and they do not belong to the species just described. They are indeterminable, but they approach the *discus* type more than the perfect form. They differ from it in the breadth and flatness of their interporiferous zones and smallness of their poriferous zones, which are unequal except in the odd ambulacrum.

Locality. Kachh. Nummulitic series. One mile east of Goir, near Narainsir. Survey-numbers C 043 B and C 043 f B.

There are two species of *Echinolampas* described by d'Archiac and Haime, and figured in their plate XIV. Figures 2 *a*, 2 *b*, 4 *a*, and 4 *b* refer to *Echinolampas Sindensis* and *E. Vicaryi* respectively. The types of the species in the Museum of the Geological Society of London are so defective that no palæontologist would now consider it advisable to found species on them. They are elongate and depressed forms ; and as there are specimens of corresponding shape in the Sind and Kachh Tertiaries, more or less well preserved, it is of importance to decide upon their greater or less similarity to the types described by the authors of 'Les Animaux Fossiles de l'Inde.'

Echinolampas Sindensis, d'Archiac and Haime*, was founded on one specimen. Its specific description is as follows:—The test is ovular, very elongate and flat, with a rounded contour, the tuberosities on the latero-posterior margin being insufficient to alter the oval curvature. The apical summit, slightly projecting, is situated at nearly the anterior third of the long diameter. The ambulacral petals very broad, flat, tolerably long, straight, and hardly contracted distally. The odd ambulacrum is a little narrower than the others. The poriferous zones are rather broad, nearly equal in the same ambulacrum, and those of the odd one are the narrowest.

Ambulacral areas unequal ; the lateral are the broader, the posterior being a little broader than the anterior.

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* *Op. cit.* p. 210, plate xiv, figs. 2 *a*, 2 *b*.

Actinal surface subplane and barely depressed centrally. The peristome is central, and the periproct inframarginal and close to the edge. The tubercles are small, close, equal.

Length 75 millim., breadth 60 millim., and height 25 millim. The relative dimensions are—length to breadth as 1 : 0·8, and length to height as 1 : 0·33.

Remarks. The test is broader posteriorly to the centre than elsewhere, and it is rather flat behind and above the periproct. According to figure 2 *b* the posterior margin is as tumid as the anterior, and certainly the apex is behind the anterior one-third.

The petals are not very broad; the antero-lateral are nearly hidden, and the terminations are not visible. The posterior are long, straight, and there is very little difference between the lengths of their poriferous zones. The specimen and the description do not agree.

The type of the other species, *Echinolampas Vicaryi*, is defective in the posterior part of the test, and was founded on one specimen only. The following is the specific diagnosis (page 213, plate XIV, figs. 4 *a*, 4 *b*):—The test is elliptical and slightly elongate, with a contour slightly angular posteriorly and but slightly high. Apex but slightly projecting, and situated at two fifths of the long diameter from the front. The ambulacral petals are large, rather broad, straight, plane, narrowed near their ends, but slightly unequal. The poriferous zones are moderately broad, rather curved, and in the posterior ambulacra the outer zone is the largest, whilst in the antero-lateral the posterior is the larger.

The lateral interradia are the largest inferiorly. The actinal surface is depressed towards the centre and raised behind. The peristome is placed anteriorly to the centre; and the buccal petals are very distinct, and rather contracted distally. The tubercles are very small, close, and those near the mouth are the largest.

Length ?, but it is stated 58 millim., breadth 50 millim., and height 25 millim.

There are three indifferent specimens of oval and elliptical depressed Echinolampads in the collection from Kachh. Two probably belong to the same species, which cannot be either of those described by MM. d'Archiac and Haime. The third is to all appearance *Echinolampas Vicaryi*. Of the first two, one is so marked in its anterior and antero-lateral petals that we have figured it without giving it a specific designation.

9. ECHINOLAMPAS, sp. Plate III, Fig. 7.

A flat, elongate elliptical Urchin, with apical system in front of the centre, and a large transversely elliptical periproct close to the posterior margin. The anterior ambulacrum is long, showing the faintest tendency to close not far from the margin; it is broad, with sunken broad poriferous and raised interporiferous zones. Poriferous zones with numerous pairs of pores, the inner pore being circular or oval, and the outer long and smaller; the costæ are distinct and rather small, and the right zone is longer than the other. The terminal pairs of both zones are slightly turned in, and the others are oblique to the long axis of the test. Ornamentation of the interporiferous area small and rather crowded, smaller and closer than that of the interradium. The breadth of this zone is slightly more than twice that of a poriferous one.

Antero-lateral ambulacra large, long, petaloid near the apex, open distally and yet slightly tending to closure. The poriferous zones are sunken, broader than those of the anterior ambulacrum, and have well-developed costæ, each with a row of granules on it. The anterior zone is short, curved, and its remote end approaches the posterior, which is long and with a double curve, the outer end turning slightly backwards beyond the line of the termination of the anterior zone, which is the shortest by about twelve pairs of pores. The interporiferous area is smaller and higher than the poriferous zone, and it is covered with a close ornamentation.

The ornamentation of the test is altogether larger and coarser actinally; the actinal surface is tumid, but depressed centrally. The mouth is in front of the centre.

Length 83 millim., breadth 69 millim., height 28 millim. Relational dimensions—length to breadth 1 : 0·83, to height 1 : 0·33.

Locality. Kachh. Nummulitic group, west of Júnagia, north of Ierá. Survey-number C 060 A f.

It will be observed that the dimensions coincide closely with those of *E. Sindensis*, but the shape of the ambulacra affords a specific distinction.

Illustration of the Species in Plate III.

Fig. 7. The test from above.

The second specimen has a higher test, and it shows part of the peristome, which has well-developed projecting bourrelets. It came from the same locality.

10. Echinolampas Vicaryi, *d'Archiac & Haime.*

A specimen, already alluded to, of this species is in the collection from Kachh, and it shows the large well-developed peristome characteristic of the type preserved in the Museum of the Geological Society. The posterior part is preserved, and shows the elliptical periproct submarginal and close to the edge. The posterior ambulacra tend to close near the margin, in consequence of the bold curve of the anterior poriferous zone, which reaches far towards the margin, passing not very far in front of the shorter and straight posterior zone.

We have not figured this form, as doubtless better specimens will come to hand.

Locality. Kachh. Nummulitic group, west of Júnagia, north of Ierá. Survey number C 060 A f.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus HEMIASTER, *Desor*, 1847.

There are two badly preserved specimens of a genus of Spatangoids in the

Nummulitic series of Kachh, which at first sight might be associated with *Linthia*; but it is perfectly evident in one specimen, which is admirably preserved in the region around the ambulacra, that there is only a peripetalous fasciole present, the lateral and posterior ambulacra are in deep grooves, and the apical system is central. The form must therefore come into the *Hemiasters*.

1. HEMIASTER DECIPIENS, *Duncan & Sladen*. Plate VI, Figs. 3–5.

The test is slightly longer than broad and broader than high; the apical system is small and central, details lost. The anterior margin is very slightly notched by the shallow groove for the odd ambulacrum, which deepens towards the apex. The broad and slightly concave floor of the ambulacrum is ornamented with miliaries, which enlarge near the pairs of pores; these, some 15 in number, are placed at the rise of the side of the groove, and are separated by low costæ. The pairs of pores have a tubercle between them; there is some distance between the end of the regular series of pairs and the fasciole, and but one pair is found in it.

The antero-lateral ambulacra are long, nearly straight, only bending slightly with the convexity forwards and inwards, and are in deep and rather narrow grooves, which become shallow distally. The greatest breadth is at two thirds of the distance from the apex, and the poriferous zones nearly close, being cut across by the fasciole.

The interporiferons area is nearly, if not quite, as broad as the poriferous zone in the centre of the petal, and is narrower than it further out.

The poriferous zones are on the slope of the sides of the groove, are very slightly sinuous, and the anterior is slightly more curved than the posterior. The pores are large, oval, subequal, and are conjugate, and each pair is separated from its neighbours by costæ with a line of distinct miliaries on them. The pores suddenly become small towards the apical system, and there are thirty-two pairs. Length of ambulacrum 21·5 millim., breadth of groove 6 millim. The ambulacra form an angle of about 110°.

The postero-lateral ambulacra, shorter and narrower than the anterior pair, are closer together, nearly straight, and are in deep grooves. The interporiferous area is rather narrower than the poriferous zone, and its details resemble those of the corresponding areas of the antero-lateral petals. There are 29 pairs of pores; and the length of the petals is 17 millim. and the extreme breadth is 4 millim. The distal end is more pointed than that of the antero-lateral ambulacra.

The keels of the interambulacra at the apex are not pronounced, and those of the lateral interambulacra are rather wide. The fasciole is widely spread, and is wide and well developed; it is large at the extremity of the lateral petals, enters but slightly within the lateral interambulacrum, and passes directly over the posterior interambulacrum in a straight line. In front a large space is included by the fasciole, for it crosses the anterior ambulacrum not far above the ambitus on a curve, convexity forwards, and it starts off on either side to the end of the long antero-lateral petal.

The ornamentation within the fasciole is very close and small, and consists of low tubercles, perforate and crenulate, surrounded by a circle of miliaries; it is very uniform except on the slope of the groove for the anterior odd ambulacrum, where it is larger and scantier. In the anterior interradia this ornamentation becomes suddenly scanty and large, and increases in these characters beyond the fasciole to the margin. Over the margin the tubercles become larger and scantier. On the other hand, the ornamentation of the lateral and posterior ambulacra abactinally is the same as that within the fasciole and thence to the margin.

Length of the specimen (fractured) 53 millim., breadth 51 millim.

Locality. Nummulitic series of Kachh. Between Maniara-Fort hill and Karray. Survey-number C 050.

Illustrations of the Species in Plate VI.

Fig. 3. Abactinal view: natural size.
4. Distal end of antero-lateral petal and fasciole: magnified.
5. Part of the anterior odd ambulacrum: magnified.

2. Hemiaster, sp. Plate VI, Figs. 1, 2.

The second specimen from the same locality had the apical system excentric in front, a broad anterior ambulacrum, barely notching the ambitus, and long, slightly curved, deeply grooved antero-lateral ambulacra. These form a wider angle than in the species just noticed; but the details are much the same, except that in this larger form there are fewer pairs of pores. The ornamentation resembles that of the other species.

The fasciole is distinct, and there is no trace of a lateral or subanal one, although the position whence the first should start is preserved.

Locality. The same as *Hemiaster decipiens.*

Illustrations of the Species in Plate VI.

Fig. 1. Abactinal view: natural size.
2. Ornamentation, actinal: magnified.

3. Hemiaster carinatus, *Duncan & Sladen.* Plate XI, Figs. 1–4.

The test is long, high, and rather narrow, slightly convex actinally, tumid at the margin except posteriorly. It is boldly tumid in front, tall and truncated behind, with a slightly re-entering curve there. The highest point is on a tall convex keel in the posterior interradium, rather nearer the posterior termination than to the apical system. The apical system is very slightly posterior. The peristome is excentric in front. The periproct is ovoid and high up on the posterior truncation close below the termination of the keel of the posterior interradium.

The apical system is very small, immediately behind the very tall and narrow keels of the anterior interradia, in front of the ascending keel of the posterior interradium, and at the junction of the broad low keels of the lateral ambulacra.

There are two large generative pores, which are separated by a rather long madreporic body, which extends posteriorly so as to separate the posterior ocular plates.

The anterior ambulacrum is broad, lanceolate, with a nearly flat floor, and has between the apical system and the position of the traversing fasciole a tall sharp keel on either side. These keels slope up suddenly from the apex, and then curve forwards at the top, diverging slightly. The groove becomes narrower to the front, and is very slight on the margin, and is still less near the peristome.

The floor of the ambulacrum is granular, and the poriferous zones are on the rise of the slope of the keels. The pairs of pores are separated by faint costæ and are close together near the apical system, five pairs being very small in front of the very minute ocular pore. Further out the pores increase in size, and the pairs become more distant: twelve or thirteen large pairs are visible within the fasciole; further out they are invisible. The pores of each pair are separated by a tubercle.

The antero-lateral ambulacra are slightly sinuous, are deep, short, broad, nearly rounded and slightly curved backwards distally, and shallow, narrow, and curved forwards near the apical system. Their grooves are bounded by the slope of the keels of the anterior interradia, and by the less pronounced tumidity and keeling of the postero-lateral interambulacra. The interporiferous areas are well developed, but are narrower than a poriferous zone. The anterior poriferous zone is the longest, and curves outwards and backwards, overlapping the end of the posterior poriferous zone. The large pores of both zones are on the slope of the ambulacral groove, except near the apex, where they are flat and close together and very small. The pores are large in the body of the ambulacrum, broadly comma-shaped, and those of the outer row are equal in size to the others; they are conjugate and separated by broad costæ ornamented with a linear eminence ending in minute granulation. There are 22 pairs of pores in the anterior zone, about seven being small and close near the apex. Ocular plates and foramina small. The ambulacra form an angle of about 75°.

The postero-lateral ambulacra are small, short, narrow, close, not one half the length of the others, and are placed in pear-shaped grooves which are shallow near the apex and deep distally. There are some pairs of small pores near the ocular plate, and the other pores are larger, and there are about 16 pairs in all.

The anterior interradia are sharply keeled between the ambulacra, and more in front they are tumid and marked with slightly gibbose plates. The lateral interradia are broadly and lowly keeled near the apex, and further out are precipitous to the margin. The posterior interradium is large, and there is a tall convex keel arising from a broad base and sloping sharply backwards.

The peristome is rather small, rather crescentic, with broad sides and a very projecting posterior lip, which is considerably below the level of the anterior one. The posterior lip is thick in the centre. The plastron, elongate and rather small, is bounded by a space between it and the mouth, where there is no ornamentation, and at the sides by ambulacra covered with minute granules. The projecting point of the plastron limits a broad keel posteriorly, and the whole is ornamented with low tubercles on slightly raised scrobicules, which are elongate and sometimes imbricating; the boss is tumid and flat and near one end of the scrobicule; and the mamelon is small and perforate. This ornamentation diminishes in size posteriorly. In front of the peristome, on either side of the anterior groove, the ornamentation is very scanty, and consists of more or less distant low tubercles with circular scrobicules, the edges of which are raised like flat rings. The bosses are low and crenulated, and the very small mamelons are perforated. Above the margin in this part of the test the ornamentation becomes smaller and closer, and near the keels smaller still.

On the flanks the ornamentation is of the distant kind and is large, and higher up it becomes smaller and closer, but the same character is noticed. The keels of the lateral interradia have a few medium-sized tubercles on them near the apex.

The posterior truncation is large and slopes downwards and slightly backwards; and there is some tumidity above the posterior end of the actinal surface.

The fasciole is peripetalous, and is large and well developed where it clings to the ambulacra, closing their ends and reaching far towards the apex; but it becomes smaller as it passes forwards from the antero-lateral petals to curve over the anterior ambulacrum, and also where it passes directly over the posterior keel. There is no offshoot to pass beneath the anus, and no lateral fasciole.

The appearance of the test from above is remarkable on account of the great arch of the anterior keels and their sloping precipitously backwards; and it is to be remarked that this view indicates that the posterior part of the test is the broadest. But seen from below, the oval outline is evident and the narrowing behind also.

Length of the test 40 millim., breadth 33 millim., height 32 millim.

Locality. Nummulitic group of Kachh. Between Maniara-Fort hill and Karray, about three miles east of Bair. Survey-numbers C 050, C 050 f c.

Illustrations of the Species in Plate XI.

Fig. 1. The test from the side: natural size.
2. The test, abactinal view: natural size.
3. Actinal view of the test: natural size.
4. One of the tubercles on the actinal surface: magnified.

Genus SCHIZASTER, *Agassiz*, 1836.

On investigating the types of *Schizaster Beloutchistanensis*, d'Archiac, from the Nummulitic of Sind in the museum of the Geological Society, it was found that their condition of preservation did not enable us to discover the position of the fasciole in front of the antero-lateral ambulacra, that the branch from the peripetalous fasciole to beneath the anus is very faintly seen, and the ornamentation is worn. Two types are labelled; and it is clear that the species varies in the breadth of the test and in the height of the keel on the posterior interambulacrum.

Several Schizasters in the collection of the Geological Survey of India from Kachh must be regarded as varieties of the *Schizaster* named after Baluchistan by MM. d'Archiac and Haime. The main difference, and in fact the only one, is that the height behind the apical system is not so great as that of the type, although the whole height there of the test may be equal to that of the type.

1. Schizaster Baluchistanensis, *d'Archiac*, variety. Plate V, figs. 5–8.

The test is tumid, elongate, longer than broad and broader than high; the margin as seen from above is rounded in front with a very faint anterior groove, slightly flattened on either side on a line with the terminations of the antero-lateral ambulacra, and more convex and widest a little further back on a line anterior to the apical system. From this point the test is curved sharply backwards, becoming narrower and almost pointed at the median line posteriorly.

Seen from below, the margin has the same contour as in the view from above, except posteriorly, where there is a slight truncation instead of a pointed end; and the truncated part is overhung (in the natural position) by the pointed end of the upper surface, the periproct immediately beneath this being visible from below. The test is tumid all round the margin except posteriorly, where it is truncated, and its highest point is in front of the posteriorly excentric apical system, on the keels which bound the anterior ambulacrum. Omitting these keels, the highest point will be the apical system, and the top of the test is continued backwards over a slight depression on to a keel in the median line. This slopes backwards and downwards posteriorly, and ends by overhanging the periproct. In front of the apex the test slopes very gradually along the line of the anterior ambulacrum, forming a gentle curve down to the tumid margin. On either side of the ambulacrum is a keel which is high slightly in front of the apical system, and which slopes in front and merges into the general surface before reaching the margin. The view from the front shows the groove for the anterior ambulacrum, the high keels diminishing forwards, the groove slightly diminishing to the peristome. Posteriorly the test is oblique from above downwards and forwards, slightly concave in the vertical line, and the lowest point there is the projection at the end of the plastron. Actinally the test is convex from side to side, flattened in the middle over the plastron, but still slightly convex there, and it rests on the plastron near the centre. The position of the peristome is far in advance of the centre, and its lower lip is slightly prominent. Finally, the plastron is slightly convex from before backwards.

The apical system is small; there are four generative pores, of which the two anterior are very small and wide apart; and the posterior are very large and wider apart than the anterior, to which they are very close. The ocular pores are small, and the anterior is between the anterior generative pores, whilst the antero-lateral ocular pores are on a line with the first pair of generative and the anterior ocular pores. The posterior generative pores are upon a narrow slightly raised keel, which passes transversely from one antero-lateral interradium to the other; and the anterior are in a depression in front of it and behind a rapid backward slope of the two anterior keels.

The anterior ambulacrum is in a decided narrow and rather deep groove, bounded by a high keel on either side except in front. Near the apical system the groove has a flat floor, which becomes concave further out, and the margins of the floor are slightly overhung by the keels. The poriferous zones are wide apart; and the pairs of pores are at the junction of floor and keel. They are rather distant, oblique, and the pores are separated by a large rectangular or square process. They become very small and lose their process before the ambulacrum is crossed by the fasciole.

The antero-lateral ambulacra, which are petaloid and small in relation to the size of the test, are placed in moderately deep grooves, which are bounded within by the sharp narrow anterior crests, and posteriorly, near the apex, by the crests of the antero-lateral interradia. The grooves form rather an acute angle with each other, are shallowest at the extremities, and the ambulacra are sinuous, broadest midway, and they are narrow and limited by the fasciole at their distal ends. The interporiferous area is narrow, slightly aslant from before backwards, and it occupies the base of the groove. The poriferous zones are broad, are placed on the slopes of the groove, and the anterior overlaps the posterior at the end of the ambulacrum, the curvature of the anterior being decided there, and the posterior zone not being quite straight but tending to bend backwards. Both zones are curved, and the anterior more so than the posterior; the anterior is bent near the apex with the concavity forwards and inwards, and there is a greater and outer curve with its concavity backwards and outwards. The curves of the posterior zone are much less than those just noticed, but they are in the same direction. The pairs of pores of one zone do not usually correspond with those of the other; they are very slightly conjugated; and a raised narrow costa, rounded and low, is on the broad space between the pairs of pores. The pores are large, comma-shaped, and the outer set are slightly larger than the inner. The outermost and innermost pores are small. There are 19 or 20 pairs.

The posterior ambulacra are very small and about one third the length of the antero-lateral pair; they are close, being separated by the posterior narrow keel, elliptical in outline, in shallow grooves; and there are about ten pairs of pores with a narrow interporiferous area. The pores are smaller than those of the antero-lateral ambulacra. These ambulacra do not reach more than one third of the distance to the posterior margin of the test.

The anterior interradia are raised into keels on either side of the anterior ambulacrum; they are narrow, very nearly parallel, have a sharp crest which is highest at a point which corresponds with the middle of the antero-lateral ambulacra, and which slopes rapidly behind that point to the apical system. There is a considerable ornamentation on the surface of the anterior ambulacrum. The ambitus has medium-sized tubercles placed on slightly raised flat scrobicules, which are circular in outline or deformed when close to others; the bosses are low and rather flattened out and crenulated; and the mamelons are small and perforate. Where there is any space between the scrobicules there is a fine granulation. Lower than the ambitus and extending below the margin to and on both sides of the peristome are larger tubercles, usually less crowded, with the same structural details on a larger scale. The floor of the ambulacrum is granular; and this condition is seen along the groove to the peristome, a tubercle coming in here and there below the margin. Higher up than the ambitus the tubercles become smaller and smaller and more crowded until the anterior fasciole is reached. On the flanks of the keels the tubercles are crowded, and are larger on the inner than on the outer side.

The lateral interradia have a keel near the apical system and some gibbosities further out; and the ornamentation is of small tubercles, which become larger towards the margin, but which never equal the medium-sized tubercles of the anterior interradium except close to the ambulacrum at the margin.

The posterior interradium has a very decided, narrow, elevated keel on it in the median line, the upper surface of which is nearly horizontal in front and curved gently behind. The tubercles of the interradium are very small near the apical system and far back, and only become slightly larger and less crowded on either side and below the periproct.

The peristome is small, far in front, and is semilunar in shape. The upper lip is a smooth narrow plane which slants from the ordinary level of the test upwards and inwards, and is marked by the oblong slits of the peristomial ambulacral pores. The lower lip is at the end of the plastron, is ridged at its free curved edge, and projects slightly downwards; it is decidedly lower than the upper part of the peristome. The plastron is irregularly elliptical in outline, is very slightly convex, and terminates posteriorly in a projection; the tubercles on it are close, and are on flat, slightly elevated scrobicules, which are longer than broad, and which radiate in lines from the projection forwards and outwards, the largest tubercles being those in front. The bosses are nearer the front than the back part of each scrobicule.

Actinally the ambulacra are slightly grooved and very plain as regards their ornamentation. Slit-like pores are seen; and the posterior ambulacra limit the plastron laterally.

The fascioles are two in number, the peripetalous and the latero-subanal.

The peripetalous fasciole bounds the end of the petaloid antero-lateral ambulacrum, and is continued inwards close to the poriferous zone as far as the inner one fourth of the ambulacrum, and therefore close to the interradial ridge; it then passes backwards and slightly inwards to the posterior ambulacrum, the greater part of the outer poriferous zone of which is environed by it. The fasciole limits the end of the ambulacrum and passes over the keel in a curved direction, concavity backwards, to reach the opposite ambulacrum. In front of the end of the antero-lateral ambulacrum the fasciole turns inwards and forwards, and reaches the top of one of the crests of the anterior ambulacrum; it passes over the crest in a long slant forwards, inwards, and downwards to form a V-shaped curve on the groove, the concavity being backwards, and then it joins the fasciole of the opposite side.

The lateral fasciole starts from a small gibbosity about halfway between the outer and inner ends of the posterior poriferous zone of the antero-lateral ambulacrum, passes as a thin line with a backward, downward, and very slightly outward trend, and then downwards, backwards, and inwards to curve beneath the periproct about halfway between it and the projection of the plastron.

The fascioles are composed of exceedingly minute granules very closely packed, and the lateral and subanal are very narrow and continuous, whilst there is a decided enlargement in breadth of the peripetalous fasciole close to the end of the antero-lateral ambulacra and quite in front.

The periproct is elliptical in shape, longest in the vertical direction, and it is placed immediately beneath the end of the posterior median keel.

Length of large specimen 27 millim., breadth 22 millim., height 18 millim.; length to breadth 1 : 0·8, length to height 1 : 0·66.

Locality. Kachh. From a cañon in Nummulitic rock between Maniara-Fort hill and Karray, about three miles east of Bair. Survey-number C 080 C f.

Illustrations of the Species in Plate V.

Fig. 5. The test from above: natural size.
6. The test, side view: natural size.
7. The test, actinal view: natural size.
8. The apical system, ambulacra, and part of fasciole: magnified.

A large and considerably injured Spatangoid is in the same bed as that just described. Its measurements are:—Length 58 millim., breadth 47 millim., height 44 millim. It appears to be an adult form of the above, but the apical system is slightly more in front than in the others.

Fig. 9. A side view: natural size.

Genus PERIPNEUSTES, *Cotteau*, 1875.

A well-marked species of this genus, which was first of all noticed by Cotteau in the Tertiary deposits of San Bartholomew in the West Indies, is in the Nummulitic zone of the Kachh Tertiaries. The following is the generic diagnosis of Cotteau:—

Test long, swollen, more or less cordiform. Apical system excentric in front. Anterior groove notching the margin strongly. Anterior ambulacrum different from the others, and formed of simple small pores. Paired ambulacral areas petaloid, narrow, long, sunken, nearly equal in length, the posterior being usually longest. Poriferous zones with small rounded pores near the summit, becoming larger, subtransverse, and conjugate further out. Tubercles unequal on the upper surface, some large and distinct, and others closer, more abundant, and homogeneous. Large tubercles closely circumscribed by the peripetalous fasciole. Peristome transverse, bilabiate, very excentric in front. Periproct oval, largely open, placed at the summit of the posterior end. Apical system compact. Four generative pores, the anterior pair closer than the posterior. Peripetalous fasciole broad, strongly angular; subanal fasciole annular.

In this definition some family characters and others of a specific value predominate. The distinctive structures of this Spatangoid are the nearly equal petals, the large abactinal tubercles included by a peripetalous fasciole, and the presence of a subanal fasciole.

The genus is close to *Macropneustes*, differing in the presence of a subanal fasciole only.

Dames[*] notices the doubtful distinction between *Peripneustes* and *Euspatangus*, and doubts whether the concave petaloid ambulacra of the former genus are sufficient to separate it from *Euspatangus*. This applies very well to the form which he has called *Peripneustes brissoides*, Leske, sp., from S. Giovanni, Ilarione; but in the species about to be described the Peripneustic characters are much more fully developed than in the Italian specimen. On the other hand, the distinction from *Macropneustes*, a genus well represented in the Egyptian Nummulitic series, is only that of the presence of a subanal fasciole in the Eastern form [†].

1. PERIPNEUSTES INSIGNIS, *Duncan & Sladen*. Plate V, Figs. 1–4.

The specimen is 79 millim. in length; and the relative dimensions are as follows:—Length to breadth 1 : 0·87, height 1 : 0·608.

The test is large and thick, somewhat heart-shaped, longer than broad and broader than high, tumid and subhemispherical in vertical outline above the rounded-off margin. Abactinally the greatest breadth is central, and the test narrows decidedly behind and less so in front, where the margin is broadly furrowed. Actinally the posterior narrowing is less than above the margin, and a subanal groove exists, which with its tumid sides gives a broad and swollen appearance to the posterior part; the margins are rounded, but less so than elsewhere in the line of the ambulacra and especially of the postero-lateral.

Abactinally the highest point of the test is behind the centre, and on the tumid posterior interradium between the postero-lateral ambulacra. There is a gradual slope forwards at first, and then a sharp one to the margin; but the slope backwards is more gradual, the curve being greater until a line between the ends of the postero-lateral ambulacra is reached, where a decidedly oblique truncation occurs, its slope being downwards and a little forwards.

The apical system is slightly excentric in front (·2 part of the whole length in front of the centre) and is in a little depression; it is small, and much longer than broad. The generative pores, four in number, are close together, the anterior pair being the most approximated and the posterior rather wider apart; they are large, and are at the summit of low crateriform eminences.

The ocular plates are large and distinct, and are slightly sunken below the level of the generative plates. The madreporic body, in relation with the right anterior generative plate, is placed between the postero-lateral generative plates and extends backwards beyond them, gradually widening so as to separate the posterior ocular plates; it narrows and ends just behind the line of the posterior edge of the posterior ocular plates, causing widening of the posterior interradium there. The surface of the madreporite is minutely but distinctly and sharply granular, there being minute foramina in the spaces between the granules.

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[*] Palaeont. 1877, p. 72.

[†] De Loriol, Monog. des Échin. numm. de l'Égypte, 1881, p. 127 *et seq.*

The anterior odd ambulacrum is in a groove which is very shallow and narrow at first, and which increases in breadth and depth to the margin, which it excavates considerably, and it is continued over, gradually diminishing, to the peristome. The pairs of pores are only visible near the apical system, and are very small and distant.

The antero-lateral ambulacra, rather sinuous, are in broad shallow grooves, which gradually diminish in depth near the distal end of the ambulacrum. The ambulacra are very wide apart, are petaloid near the apex, and open at the other end, which does not extend to near the margin; they are curved slightly near the apex, the convexity being forwards, and more decided further out, where the curve alters in its direction and the convexity looks forwards and inwards.

The poriferous zones, which are well developed, are situated on the slopes of the groove; and the pairs of pores, small in size near the apex, increase suddenly in dimensions. The zones increase in size about halfway to the end and then diminish, the ends being rather narrow, but not coming to a point; they show no tendency to close. The pores are large, subequal, and are rather more elliptical than circular in outline; they are conjugate by a broad shallow groove, which is interrupted by a ridge which surmounts the broad shallow costa between each pair. This ridge usually has from seven to eight close granules in linear series on it, or some or all of the granules may coalesce to form two or three in a broken line or a ridge. There are about 36 pairs of pores in each poriferous zone. At the end of the poriferous zone the pores diminish greatly in size, become very elongate, and are rare and distant.

The interporiferous area is narrower than the poriferous zone, and it becomes broader towards the end, where it equals the diminished zone in breadth. Its ornamentation is scanty, and consists of a small tubercle which is placed at the junction of the costa with the zone, and of small granules scattered very sparingly and of about the same dimensions as those on the costæ.

The postero-lateral ambulacra form a small angle by their divergence, and are in broad shallow grooves sloping rather on the sides of the posterior tumid interradium. They are petaloid at the apex, are broad further off, and they retain their breadth close to the end, which is remote from the margin, the only narrowing consisting of a closer approach of the pores of the last four or five pairs. They are longer than the antero-lateral ambulacra, about equal in breadth to them, and are slightly curved, the concavity being directed forwards, outwards, and downwards. The poriferous zones have about 42 pairs of pores, those nearest the apex being very small. The pores are subequal, but towards the distal extremity of the ambulacrum the outer pores become more elongate elliptical than the others; at this part the pores become closer, and at the end smaller. The interporiferous area is smaller than a poriferous zone, barely equalling half its breadth. The greatest breadth of the ambulacra is 7 millim., and the length of the antero-lateral is 35 millim., that of the postero-lateral being 43 millim.

Actinally, the region of the postero-lateral ambulacra is broad, long, and nearly bare, having a few scattered rounded granules on it anterior to the posterior margin. The openings for pores are few in number.

The interradia are tumid abactinally from before backwards. The anterior portion of the test is marked by the excavation of the broad and moderately deep groove at the ambitus, and there are two slight vertical projections on each side of the groove, which are well defined by a slight gibbosity on each plate.

The lateral interradia are tumid around the apex, and, as this condition is noticed in the others, the apical system is in the midst of a slight depression. The posterior interradium is narrow and long, convex from side to side and from before backwards; it forms a well-rounded tumid mass between the posterior ambulacra, is pinched in a little on either side between their ends, and is broadly truncated posteriorly, the slope looking backwards and downwards obliquely. There is a swollen look about the interradium at the margin, and also actinally on either side of a shallow groove below the periproct. The plastron is long, triangular, and has a slight central keel placed longitudinally and reaching two thirds of the distance to the mouth. The plastron is slightly convex from side to side.

The peristome is excentric in front and rather close to the anterior margin; it has a well-defined arched posterior lip, which is covered with small tubercles and granules.

The periproct is large, broadly elliptical, its greatest diameter being in the vertical direction, and it is rather pointed above and below. Below it is a shallow broad groove.

There are two fascioles—a peripetalous, which is very narrow and which runs a rather irregular course; and a subanal, which is a little broader than the other.

The peripetalous fasciole is broadest below the posterior poriferous zone of the antero-lateral ambulacra, with which it is not in contact, being 5 millim. nearer the margin than the last pair of pores. The fasciole then passes forwards and slightly upwards to reach a gibbosity on the outer vertical low keel of the anterior interradium; it then passes downwards and towards the median line to the keel by the side of the odd ambulacrum, and passing still towards the median line, it crosses the ambulacrum with a broad curve, convexity downwards, just as the ambitus slopes towards the base, and 19 millim. from the lowest point of the groove in the anterior part of the test, and 40 millim. from the apical system. Behind the antero-lateral ambulacra the fasciole turns suddenly but remotely, and then curves slightly into the area between the ambulacra before passing downwards and backwards to reach the end of the postero-lateral ambulacra, which it bounds; it then crosses the posterior interradium, with a low curve, convexity upwards. It consists of a ribbon-shaped narrow band marked with close minute granules, and it is bounded by a single series of small low tubercles.

The subanal fasciole includes the broad tuberosities on either side of the groove beneath the periproct, and it passes over the edges of this groove. Seven pairs of pores of the postero-lateral ambulacra are just within its outer curve.

The ornamentation of the test, abactinally, is different within the peripetalous fasciole, and beyond it or nearer the margin of the test. Within the fasciole on the lateral and posterior interradia there are a few definitely placed, and on the anterior interradium more numerous and less definitely placed, small tubercles, still smaller tubercles, and granules. The first kind of tubercles are flat, low, truncated, crenulated, conical bosses, surmounted by low mamelons, which are flat above and perforated; they stand in very shallow circular scrobicular spaces (often non-existent) surrounded by a single circle of granules; some are placed rather wide apart, and tubercles of the second kind may intervene, or else the scrobicular series of granules may touch.

In the posterior interradium the larger tubercles are very definitely placed on either side of the median line, and near the apex there is a single row, one tubercle to each plate, then two plates have two; and the next plates on either side have three, one being placed behind the others so as to form a triangle. Then small and large tubercles are gradually added to succeeding plates to form widely open angular series, the point being backwards; so that with the increasing breadth of the plates the numbers of tubercles increase in the vandykes. An indication of this style of ornamentation is seen in the lateral interradia, the number of larger tubercles increases on each successive plate from the apex to the fasciole, and the arrangement is in lines converging with widely open angles.

The anterior interradium has more numerous tubercles, and placed in irregular rows in each plate, but much more sparingly near the apex than lower down. The second kind, or smaller tubercles, also crenulate and perforate, are scattered generally over the surface, and are fewest along the median lines of the interradia. The granules are usually in circles around the larger tubercles, and there may be considerable spaces without them.

Below the fasciole in the lateral posterior interradia there are no large tubercles, but crowds of the second kind, which here and there are larger than the second kind above the fasciole; but in the anterior interradium there are tubercles below the fasciole nearly as large as those above and crowded together.

Actinally, the ornamentation consists in front and at the sides near the mouth of large crenulate and perforate tubercles placed on flat disks, nearer one side than the other, crowded and environed by granules. Further back the dimensions of the tubercles diminish and they are less crowded.

Within the comparatively bare posterior ambulacra the plastron has its tubercles increasing in size from the central keel, at a point anterior to the subanal fasciole, outwards and forwards. The tubercles are crowded below the anal groove and on either side within the fasciole.

Locality. Kachh. From a cañon in Nummulitic rock between Maniara-Fort hill and Karray. Survey-number C 050.

Illustrations of the Species in Plate V.

Fig. 1. The test, side view: natural size.
2. View from above: natural size.
3. The apical system: magnified.
4. Part of the posterior ambulacrum and fasciole: magnified.

Genus EUSPATANGUS, *Agassiz*, 1847.

Urchins of moderate size, and in general depressed. Ambulacral petals rounded, closed, splayed. Ambulacral areas with large tubercles, crenulated and perforated. Fasciole peripetalous, not sinuous, and circumscribing the large tubercles. Posterior interradium without large tubercles. A subanal fasciole present environing the anal plastron.

1. EUSPATANGUS AFFINIS, *Duncan & Sladen*. Plate XII, Fig. 2.

There is a much crushed specimen from the Nummulitic series of Kachh, the upper surface of which and part of the actinal area are fairly preserved. It has very much the appearance of a *Maretia*, and especially of those forms which have a faint fasciole, which is not invariable. The test was certainly not high during life, and is now very flat, not from crushing, but apparently from contraction or falling-in after death. It is notched in front, and a bold furrow is continued to the very excentric in front peristome.

The antero-lateral ambulacra open at a very wide angle, and the poriferous zones are slightly sunken, the interporiferous the broadest, being slightly raised. The posterior poriferous zone is the longest and is curved, concavity forwards. The anterior is deficient in its development of pores for a short distance from the apex, and the line of rudimentary hollows representing the position of pairs is directed inwards and forwards; the remainder of the zone is curved more decidedly than the posterior zone and in the same direction. The ambulacra are broad towards the apical end and become narrow distally, the pores becoming closer and the interporiferous area diminishing in breadth. The pairs of pores are in deep grooves, separated by broad granular costæ; the inner pore is round, and the outer, much the largest, is comma-shaped.

The posterior ambulacra, much longer than the others, are separated by a low broad keel, and make an acute angle; they are very slightly sinuous. Narrow and coming to a point distally, they are rather broader midway, and increase to the first third of their length; nearer the apical system they become narrower. The poriferous zones, longer and broader than the others, are sunken and oblique on the sides of the raised interporiferous area; the anterior is more curved than the posterior; and in both, especially in the posterior, the pairs of pores nearest the apical end are ill-developed. The apical system is small, the pores close; and the madreporic body extends far back between the posterior ocular plates. There is an excessively faint groove with a rounded keel on either side of the apical system, in which the very small pores of the anterior odd ambulacrum are placed.

The interradia differ much in size; there are numerous large, sunken, crenulate and perforate tubercles in the anterior and lateral; they are in four or five concentric rows, and they decrease in size towards the margin. One exists on either side of the median line in the posterior interradium.

The whole abactinal surface is minutely and distinctly granular with miliaries, and amongst them are sparsely distributed very small tubercles.

The peristome is large; its outline is more than semicircular, and, behind, the lip is stout, straight from side to side, and dependent.

A large tuberculation of prominent bosses and large mamelons, placed on flat scrobicules surrounded by slightly raised divisional deformed circles, exists actinally. It is largest on either side of the posterior ambulacra behind the mouth, smaller in front, and diminishes towards the margin, over which it merges into the minute tuberculation of the abactinal surface. The plastron, long and not very broad, and the ambulacra on either side are bare until close to the projecting point beneath the truncation for the periproct. A short triangular process of tubercles extends in front of this point, and merges into the ornamentation of the subanal plastron, which is environed by a subanal fasciole.

An exceedingly faint fasciole is peripetalous and bounds the great tubercles. (The anus and the test close by are crushed.)

Length 46 millim., breadth 37 millim., height 9 millim. (crushed).

Locality. One mile east of Goir, near Narainsir. Nummulitic series of Kachh. Survey-number C 043 B.

Illustration of the Species in Plate XII.

Fig. 2. Abactinal view: natural size.

2. EUSPATANGUS ROSTRATUS, *d'Archiac.* Plate VII, Figs. 1–8.

This species is described by MM. d'Archiac and Haime[*], and the types are in the museum of the Geological Society of London. The condition of the specimens was not sufficiently good to enable a reliable diagnosis, and the figures given by those authors are restorations. The peculiar abortion of the inner pairs of pores of the anterior poriferous zone of the antero-lateral ambulacra, which is seen in the specimens lately collected, is not visible in the old types, and there is no trace of a fasciole in these last. The shape and the position of the great tubercles enable *Euspatangus rostratus* to be recognized; but of course the generic position of the form is open to doubt, and we have considered it in our remarks on the fauna.

A considerable number of specimens of different sizes is amongst the collection from Kachh, and some of them are very perfect in their condition. Some are identical in shape with the types of d'Archiac and Haime, and others are more bilobed or notched in front than the original type.

MM. d'Archiac and Haime give the following diagnosis:—

Body elongate, suboval; subbilobed in front, rather attenuated behind, and truncated at the extremity; rather thickened behind. Ambulacral petals tolerably well closed, rather sharp-pointed, moderately broad, and rather long. Poriferous zones rather narrow, costulate. Anterior ambulacrum only slightly depressed in front, with indistinct pores. The lateral interradia are broader than the anterior, and the posterior is narrow and swollen behind; it is smooth like the ambulacra, but the others are covered with large tubercles unequal in size and sunken in shallow fossettes. The peripetalous fasciole appears to be submarginal. The periproct is marginal, suboval, and angular above, higher than broad. Inferior aspect nearly plane, but swollen in front of the anus. The peristome is at the anterior two sevenths of the great axis. Good-sized tubercles are on the lateral interradia.

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[*] *Op. cit.* p. 218, plate xv, fig. 3.

The authors add, "Nous n'avons pas pu nous assurer complètement de la présence d'une fasciole péripétale dans cette espèce." This fasciole does not occur in the specimens from Kachh, and it is absolutely invisible in the type described above.

To the above diagnosis may be added:—The inner pores of the anterior poriferous zone of the antero-lateral ambulacra abort; the madreporic body extends far back and separates the posterior ocular pores; the subanal fasciole is distinct; the plastron is large and wide; the great tubercles are crenulated slightly.

There is some variation in the shape with age, and the younger forms are less notched (Plate VII, fig. 8).

Localities. The species is found in the Nummulitic zone, and also in the higher horizon with *Orbitoides*. From three or four miles north-east of Pipúr: Survey-number C 039 f. The same, but from a higher bed without Nummulites: Survey-number C 039 A f. From upper part of Nummulitic group with *Orbitoides* (Oligocene), from near Kapúrásir, north of Kayári: Survey-number C 035 f.

Illustrations of the Species in Plate VII.

Fig. 1. The test from above: natural size.
2. Actinal view: natural size.
3. Posterior view: natural size.
4. Apical system: magnified.
5. Sunken tubercle: magnified.
6. Pairs of pores: magnified.
7. A linear longitudinal section: natural size.
8. A specimen barely notched in front.

V. *Description of the Fossil Echinoidea from the Beds immediately above the Nummulitic Series, with Orbitoides in some instances, from Kachh.*

Order **ECHINOIDEA EXOCYCLICA.**

Suborder GNATHOSTOMATA.

Family CLYPEASTRIDÆ.

Subfamily EUCLYPEASTRIDÆ.

Genus CLYPEASTER, *Lamarck*, 1801.

Specimens of three closely allied species of *Clypeaster* are in the collection from Kachh. They come from a bed without Nummulites; but their mineral condition resembles that of the upper part of the Nummulitic group, or that which has Orbitoides.

Unfortunately only part of the specific diagnosis can be satisfactorily determined, as the apices are wanting; but the species are not those mentioned by MM. d'Archiac and Haime and Grant.

1. Clypeaster Sowerbyi, *Duncan & Sladen.* Plate XII, Fig. 11.

The test is flat and very slightly elevated at the rosette only, the margin is barely swollen, and the whole test is longer than broad; it is truncated and indented for a short space behind, rather straight at the sides, truncated at the posterior lateral angles, and rounded in front, the curve being less at the margin of the median line of the anterior interradia than quite in front. There is a slight depression where the petals spring from the test.

The petals are widely open, slightly swollen, have broad interporiferous areas; and the zone of pores, broad in the third quarter of the length, attenuates towards the open extremity.

The anterior odd ambulacrum is the longest, and is long and ovate; it is not closed; and the zone of the right side is slightly shorter than the other. The antero-lateral ambulacra are the shortest and narrowest; the terminal pairs of pores of the posterior zone tend to flare backwards.

The postero-lateral ambulacra are of the breadth of the odd one, and are slightly shorter. The ornamentation of crowded small tubercles is carried over the costæ in a single row. The actinal ornamentation is larger than the abactinal. The periproct is close to the posterior edge, and the peristome is in a slight depression of the flat test.

Length 55 millim., breadth 50 millim., height 10 millim.; length of odd petal 15 millim., of antero-lateral 11 millim., of postero-lateral 14 millim.; breadth of odd and postero-lateral petals 9·5 millim., and of the antero-lateral 8·5 millim.

Locality. Kachh. Three or four miles N.N.E. of Pipúr, from a bed higher than those with Nmmulites. Survey-number C 039 A.

Illustration of the Species in Plate XII.

Fig. 11. The test, from above.

2. Clypeaster Carteri, *Duncan & Sladen.* Plate XII, Fig. 12.

The test is depressed, faintly rounded posteriorly, straight at the sides, rounded in front, and slightly curved at the margin of the anterior interradia. The length is greater than the breadth, and the breadth is very equal between the lateral ambulacra; the shape is that of a pentagon with the angles truncated and more or less rounded. The margin is slightly tumid, and the rosette is slightly elevated. The petals are slightly swollen and are widely open; they are broad and have large poriferous zones. The odd and the postero-lateral petals are nearly of the same length and are longer than the antero-lateral. The postero-lateral petals are the broadest, and the odd one is the narrowest, the antero-lateral being a little broader than it. The poriferous zone of the odd ambulacrum is as broad as the interporiferous area, and that of the lateral petals is nearly as broad. The postero-lateral interporiferous area is broader than the others.

The ornamentation is small, but is less on the ambulacra, and a row of granules extends along the costæ.

Length 63 millim., breadth 54 millim.; breadth of posterior ambulacra 12 millim.; length of odd ambulacrum 15 millim.

Locality. Kachh. Three or four miles N.N.E. of Pipúr, from a bed higher than those with Nummulites. Survey-number C 039 (a).

Illustration of the Species in Plate XII.

Fig. 12. The test, from above: natural size.

This species, closely allied to the last, has broader and coarser poriferous zones and a larger ornamentation.

3. Clypeaster Faloriensis, *Duncan & Sladen.* Plate XII, Fig. 15.

The test is depressed, rather tumid at the margin, slightly hollowed out actinally, and very slightly elevated at the rosette. The length is greater than the breadth, and the greatest breadth of the irregular pentagon is on a line with the antero-lateral ambulacra. The margins are slightly reenteringly curved on the anterior interradia, and the front and hinder angles are bluntly rounded.

The petals are very long, rather narrow, decidedly tumid, not very broad, and are widely open distally. The poriferous zones are rather straight, and the interporiferous areas, tumid and narrow, are not more than double the width of the poriferous zones. The odd ambulacrum is the longest, and its right poriferous zone is shorter than its fellow; its breadth is the same as that of the others: the openness of the distal end is remarkable. The antero-lateral ambulacra, next in length, are widely open, and the posterior poriferous zone turns back at the end. The posterior ambulacra are the shortest, and their breadth is the same as the others. The ornamentation is distinct, small, and is closer within the ambulacra; a line of tubercles is on the very low costæ.

Length 70 millim., breadth 61 millim.; length of odd petal 25 millim., of antero-lateral 22 millim., and of posterior 20 millim.; the breadth of the petals is 10 millim.

Locality. Kachh. Upper part of Nummulitic group, with *Orbitoides.* Falora river, near Bábúa Hill. Survey-number C 166 f.

Illustration of the Species in Plate XII.

Fig. 15. The abactinal surface: natural size.

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Subfamily ECHINOLAMPINÆ.

Genus ECHINOLAMPAS, *Gray*, 1825.

1. Echinolampas, sp. Plate II, Fig. 5.

A portion of a test, which has weathered out of a mass of Nummulitic limestone, shows much of the anterior part above the apical system, the anterior and antero-lateral ambulacra, and part of the posterior ambulacra. The interporiferous areas of the antero-lateral and postero-lateral ambulacra are tumid and raised above the level of the test. The odd ambulacrum is narrower and shorter than the others. The apical system is excentric in front; and the test slopes rapidly in front, where the margin is well rounded. The anterior poriferous zone in the antero-lateral ambulacra is short; and the ornamentation is crowded.

Locality. Kachh. Between Bayow and Didápúr, south-west of Lakpat. Survey-number C 034 f.

Illustration of the Species in Plate II.

Fig. 5. The test, included more or less in rock: natural size.

This species appears at first to resemble an exaggerated variety of *Echinolampas globulus*, Lamk.; but as the specimen is so incomplete we do not associate it with any species.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus EUSPATANGUS, *Agassiz*, 1847.

1. EUSPATANGUS ROSTRATUS, *d'Archiac.*

This species has been noticed in describing the Echinoidea from the Nummulitic series of Kachh (p. 47). Its highest habitat is in the *Orbitoides* beds near Kapúrásir, north of Kayári. It is also found in the Khirthar (Nummulitic) and Nari (Oligocene) series of Sind.

VI. *Description of the Fossil Echinoidea from the Miocene Series of Kachh.*

Order **ECHINOIDEA ENDOCYCLICA.**

Family CIDARIDÆ.

Genus CIDARIS, *Klein*, 1734.

The test is thick, circular in outline, and equally flat above and below. The ambulacra are narrow and undulating, and only carry very small tubercles or granules in from two to six rows. Interambulacral areas at least four times as broad as the ambulacral, with two rows of large tubercles, from four to seven in a vertical row, perforated, and either crenulated or not. Scrobicules large, either circular or elliptical. Miliary zones more or less broad and sometimes depressed. Poriferous zones narrow, formed of series of pores, the pairs of which are not conjugated by furrows.

1. CIDARIS HALAENSIS, *d'Archiac & Haime.* Plate VIII, Figs. 7, 8.

This species was founded by MM. d'Archiac and Haime on a portion of a test, on which a part of an interradium and only part of the vertical half of two ambulacra are to be seen[*]. An almost exactly corresponding portion is in the collection from the Arenaceous series of Kachh; but the triple row of small tubercles on one half of an ambulacrum within the non-conjugate poriferous zone is visible. The portion of the test has many resemblances to a part of a *Goniocidaris*; but under the unsatisfactory circumstances we leave the form as MM. d'Archiac and Haime placed it. The great characteristic is the height of the test.

Locality. Arenaceous series near Warsar, north of Jakao. Survey-number C 068.

Illustrations of the Species in Plate VIII.

Fig. 7. Part of a test: natural size.
8. Part of an ambulacrum: magnified.

Genus GONIOCIDARIS, *Desor*, 1846.

The coronal plates are more numerous than in the other genera of Cidaridæ, and the sutures of the plates are sunken, forming deep impressions along the vertical median line and also along the horizontal margins of the plates. Pits exist at the junction of the horizontal and vertical lines. The tubercles are perforate and non-crenulate. The ambulacra are narrow. The spines are cylindrical, and their surface is covered with ascending spines; they are often flaring and cupped at the extremity.

The Arenaceous Miocene Tertiaries of Kachh contain plates and spines of a species of *Goniocidaris*; and a closely allied or identical species is found in the white limestone of the Mekran coast. But in this last instance the spines are much larger than in the Kachh deposit. The form approaches *Goniocidaris tubaria*, Lamk., sp., from the Australian and Tasmanian seas; and it has the scrobicular circle elliptical and the boss and mamelon not very large. There are about eight primary tubercles, and there are several rows of small miliaries outside the row of secondaries around the scrobicular circle. The interporiferous area has six small tubercles in a transverse row (three on each plate).

1. Goniocidaris affinis, *Duncan & Sladen*. Plate VIII, Fig. 9.

The interambulacral plates are broader than high, and slope up to the slightly sunken scrobicule, which covers much space. The boss is a broad, short, truncated cone, with a groove at its top, at the base of the large perforate mamelon. A row of secondaries surrounds the scrobicule, and is composed of separated tubercles with rather long mamelons, a miliary or a row of three intervening. Beyond this row, towards the median groove, is a second, of smaller tubercles, and it is less defined; and still nearer the edge of the plate is a row of miliaries, a second existing on the large plates. There is only the row of large secondaries on the upper and lower part of the plate, but on the lower edge there is an ill-defined row of small miliaries also.

The transverse grooves between the plates are linear, rather deep, and the median is well defined; but the pitting at the angles is very slight. The ambulacra are undulating; the pairs of pores are separated by an elevated narrow ridge, and there is a small tubercle close to the inner pore on the interporiferons area, and three smaller ones (or one nearer the actinostome) towards the median line. The test is thin, and the sutural markings are distinct on the inner surface.

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[*] *Op. cit.* p. 196, pl. xiii, fig. 2.

Locality. Arenaceous series of Kachh, near Warsar, north of Jakao. Survey-numbers C 068, C 068 F.

Several fragments which are united in a mass show that the test was high and that the plates were numerous in vertical series.

Illustration of the Species in Plate VIII.

Fig. 9. The plates: natural size (actinal end upwards).

There are several well-marked spines in the collection from the Arenaceous series of Kachh, some of which belong to species of *Goniocidaris* (Plate VIII, Figs. 11, 13, 14), and show the depressed cup-like terminations, and others belong to other Cidaridæ (Figs. 10, 12).

Family ARBACIADÆ.

Genus CŒLOPLEURUS, *Agassiz*, 1840.

1. Cœlopleurus Forbesi, *d'Archiac & Haime.* Plate XII, Fig. 1.

This species was described and figured by MM. d'Archiac and Haime from a single specimen, which was much crushed and deformed (*op. cit.* p. 200, pl. xiii. fig. 6). Enough remained, however, to form a good specific diagnosis.

In the collection from Kachh there is a broken specimen showing the greater part of the apical system and the upper part of an ambulacrum and interradium tolerably perfect.

We add therefore a description of these parts, which is more or less defective in the work just quoted.

The anal ring is irregularly pentagonal in outline and is slightly raised above the ordinary test-level; one angle is posterior. The five generative plates, which are large, enter into the formation of the ring, and the five oculars do not, but they slope upwards from the ambulacra to the suture between the nearest generative plates.

The madreporic is the largest plate, and the others are broad at the edge of the ring and unite with their fellows to the right and left by a short straight suture. The plates are about as long as broad, and their free end is a wide angular projection, which is at a lower level on the test than the end of the ocular plate on either side. A re-entering curve is on either side, and reaches the straight suture. The generative pore is large and circular, and is at about three fourths of the length of the plate from the ring. Close to the edge of the ring there is a little bunch of small tubercles, about four in number, and beyond it are one or two others; one has the appearance of having been large and prominent on either side. Small ridges and grooves radiate from the bunch right and left, and some pass over onto the ocular plates. The angular part of the plate is free from these ridges; but a curved groove, convexity upwards, intersects the plate on a level with the generative pore.

This species occurs in Kattywar, and its details will be more carefully considered in treating of the fossils of that locality.

Illustration of the Species in Plate XII.

Fig. 1. Part of the test: magnified.

Family GLYPHOSTOMATA.

Subfamily TEMNOPLEURIDÆ.

Numerous specimens of the beautiful Echinoid which was described and figured by MM. d'Archiac and Haime[*] as *Temnopleurus Rousseaui*, d'Archiac, occur in the Arenaceous or Miocene deposits of Kachh north of Akri, south of Bair. They are often so well preserved that many of the structural peculiarities which are not visible in the very unsatisfactory types in the museum of the Geological Society are readily studied; for instance, the apical system and the peristome. Some of the specimens are worn; and this enables us to compare the sutures of the coronal plates with those of *Temnopleurus toreumaticus* from the present Indian Sea. The structure of the ambulacral plates is visible in some worn specimens; and it is clear that the statement made by MM. d'Archiac and Haime that each plate is pierced externally by three pairs of pores is incorrect. The plate is really composed of three, two large and one accessory, and each of these is perforated by a pair of pores. The first two enter into the composition of the plate beneath the ornamentation, across which, however, the sutures run; and the third is a small plate not entering much into the composition of the plate proper.

The pair of pores are close, and in some places the usual slight curving of triplets is not seen.

The fossettes along the horizontal sutures are, as stated by MM. d'Archiac and Haime, "peu profonde" and broad, and nearly as long as broad. We notice that the suture is seen at the bottom of the fossette, and that this state differs in the same specimen actinally and abactinally and at different stages of growth—the young and old forms having very differently shaped and ornamented ambulacra. In some specimens the zigzag median line of the ambulacra is very visible, in others it is much less so. Each plate has a large tubercle on it near the poriferous zone, and closer to the actinal than the abactinal transverse suture. A smaller tubercle is close to the angle of the plate near the median zigzag line, and three miliaries are above the larger one, curving above it, whilst one or two others are between it and the smaller tubercle, according to the growth of the individual; or the miliaries may be in a transverse line above the larger tubercle, and one or more may be between it and the smaller. The interradial plates halfway between the apex and peristome are about twice as broad as they are high. According to the original describers, "they all show little fossettes in their transverse sutures, which are rather deep, rounded, and rather elongate and subangular in the vertical direction. The number and size of these fossettes often vary according to position. Near the apical system two exist on each suture; then three and four (which are, however, very small) are seen with descent towards the ambitus. On approaching the peristome the number and size diminish, and they become very small and slightly pronounced." It is correct to state that, from apex to actinostome, there are two vertical rows of fossettes in relation to each vertical row of plates; also where the angle of a plate impinges against the end of the suture of the one on the other side of the median line there is a fossette; and, moreover, occasionally where the suture touches the poriferous zone there is one; so that the number of fossettes varies with growth and individuality. Now we find that they are all shallow, that a line of suture crosses their floor, that when wearing has occurred the sutures are in plain lines, and that there is no undermining or deep perforating as there is in *Temnopleurus toreumaticus* and in the species of *Salmacis*.

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[*] *Op. cit.* p. 205, pl. xiii, fig. 10.

The fossettes along the transverse sutures have their upper and lower margins formed by oblique concavities in the upper and lower interradial plates; and their inner and outer boundaries are formed by processes which are in relation with the tubercles of the plates. A large tubercle is on the middle of each plate, and nearer the actinal surface a smaller tubercle is on either side of it at some little distance; and the vertical processes which limit the fossettes are abactinally and actinally to those three tubercles. Very small tubercles or miliaries with a few larger miliaries form an arch over the large tubercle, and extend over the others, or are in a straight line. The fossette at the angle of the plates in the median line does not reach to any depth. It is evident that the plates are thick, and that, as they grow exogenously, spaces are left along the line of the sutnres. The fossettes are not seen in the very young form; and in some large specimens there is so little trace of them that they resemble species of *Salmacis*, and the plates are then not bevelled. There is great variation in the height of the plates.

The peristome is small and sunken, and the cuts are exceedingly small. The apical system is usually symmetrical, but in some specimens there is an obliquity of a long axis which recalls *Glyphocyphus*.

The apical system closely resembles that of *Temnopleurus toreumaticus*. The madreporic genital plate is the largest, and the others are large and project onto the median interradial space with a bluntish angle; the pore is large and not close to the edge, although not far removed. The ocular plates are much smaller than the others, and are concave towards the poriferous zones. A row of granules is on each plate near its apical part.

The shape of the test is rarely preserved except in young forms; it is moderately swollen, flattish, and ingoing actinally, and more or less turban-shaped above. (See notice of the shape in the description of the Kattywar Echinoidea.)

It is clear that the tubercles are imperforate and non-crenulate. In about forty specimens we found one with two crenulate tubercles. The fossettes do not resemble the true pits of *Temnopleurus*, *Pleurechinus*, *Salmacis*, &c.*

On examining the specimens, descriptions, and drawings of the species of *Dictyopleurus* from the Ranikot series of Sind †, the resemblance to those now under consideration is seen to be great. Yet these Miocene forms depart from the type, and even from that of *Dictyopleurus Haimei*, nobis ‡. The obliquity of the axis of the anal opening exists in some forms it is true, but in most the opening is circular and there is no obliquity. The tubercles are non-crenulate and imperforate in the Miocene forms, and this and the evidently ornamental character of the fossettes recall *Temnechinus* of Forbes. Admitting the alliance of these Miocene species with the genus *Dictyopleurus*, are they separable from *Temnechinus*? The structure of the ambulacra and fossettes in all is that of *Temnechinus*; and the only difference in the ambulacra is that, instead of there being one large tubercle with a vertical prolongation of the plate close to it actinally, which separates the two fossettes of each plate, as in *Temnechinus*, the Kachh forms have three tubercles and corresponding fossettes. But as these fossettes are mere matters of ornamentation, the importance of considering the species as belonging to *Temnechinus* is enhanced. It is curious that in their great work MM. d'Archiac and Haime should have misrepresented Forbes, and endeavoured to render his genus of no great value. Indeed they absorb the four species of the Crag (*Temnechini*) into the genus *Temnopleurus* (*op. cit.* p. 202), and make a great mistake regarding the geographical distribution. They state:—"La distribution géographique des espèces fossiles du genre *Temnopleurus* mérite d'être remarquée, puisque sur les neuf qui sont connues, *quatre appartiennent au Crag d'Angleterre*, et cinq aux dépôts nummulitiques de la Chaîne d'Hala, sans que jusqu'à présent on en ait trouvé aucune autre ailleurs." The species described by MM. d'Archiac and Haime did not come from the Nummulitic of India, but from the Miocene. No true Temnopleurid is found therein. Justice and the rules of classification demand that the distinction which Forbes made between *Temnechinus* and *Temnopleurus* should hold good ("Echinoderms of the Crag," Pal. Soc. 1852, p. 5). The attempt on the part of MM. d'Archiac and Haime to absorb *Temnechinus* fails in the face of the knowledge of the morphology of the test of *Temnopleurus* which has been attained since their time.

Forbes thus diagnosed *Temnechinus*:—"Body more or less spherical; ambulacral and interambulacral segments developed, bearing on their plates, whose sutural margins are mostly excavated, tubercles of various sizes. Vent central; genital disk surrounding the anal space, composed of five prominent genital and five ocular plates, all perforated and alternating; one of the former combined with a madreporiform tubercle. Ambulacral avenues composed of pairs of pores indistinctly ranked, their ranks confluent throughout. Spines of one order."

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* Martin Duncan, Journ. Linn. Soc., Zoology, vol. xvi. p. 343.

† Duncan and Sladen, Pal. Ind., Fossil Echinoidea of Sind, Part II. plates ix, x, p. 36 *et seq.*

‡ *Op. cit.* p. 40.

By omitting the family peculiarities we might diagnose the genus as:—Spherical or tumid turban-shaped Urchins. Apical system well developed and regular; peristome small, sunken, with very small cuts; ambulacral pores nearly straight in series; transverse sutures of ambulacra and interradia with fossettes. Tubercles non-crenulate and imperforate. The negative characters are the absence of true pits along or at the ends of sutures, and the absence of obliquity in the apical system. Occasionally a crenulated tubercle is seen.

Temnechinus, thus restored, differs from *Temnopleurus* and its subgenus *Pleurechinus*, for these have true pits at the angles of plates which undermine the test, and are accompanied by a knob-and-socket jointing of the plates.

In *Dictyopleurus* (Foss. Echin. of Western Sind, p. 38) the apical system is oblique and an ocular plate enters the ring; the pores are continuous in series, and the ornamentation is of raised zigzag ridges narrow or broad; there are no true sutural pits; tubercles crenulate and perforate.

Arachniopleurus has a costulate ornamentation peculiar to itself, and no true pits.

Genus TEMNECHINUS, *Forbes*, 1852.

1. Temnechinus Rousseaui, *d'Archiac*, sp. Plate XI, Figs. 7–11.

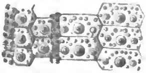
The species remarked on above, which is so characteristic of the Kachh Miocene.

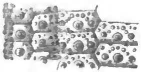
Locality. North of Akri, south of Bair. Miocene series. Survey-numbers C 054, C 054 A f.

Illustrations of the Species in Plate XI.

Fig. 7. The test: natural size.
8. The apical system: magnified.
9. Part of an interambulacrum and a poriferous zone: magnified.
10. Part of a worn ambulacrum: magnified.
11. Part of a perfect ambulacrum: magnified.

Amongst the specimens of this species are several which, although quite as large as the type, have only slight traces of sutural fossettes, or do not have them at all. The rest of the ornamentation is the same as in the type.


Plates without fossettes.


Plates with slight fossettes.

Order ECHINOIDEA EXOCYCLICA.

Suborder GNATHOSTOMATA.

Family CLYPEASTRIDÆ.

Subfamily EUCLYPEASTRIDÆ.

Genus CLYPEASTER, *Lamarck*, 1801.

1. Clypeaster depressus, *Sowerby**. Plate X, Figs. 5–9.

Many specimens of this species are in the collection from Kachh, and also in the Museum of the Geological Society, which contains the type.

The alliance to *Clypeaster scutiformis*, Lamk., is of the closest; and the scooping out of the actinal surface of the test, noticed by A. Agassiz in that species, is evident.

The specimens are of different sizes, and some are very young. There is a variety which is rather more elongate than the types (Plate X, Figs. 5 & 7), and which renders it necessary to absorb *Clypeaster profundus*, d'Archiac and Haime.

The usual shape of large forms is depressed, hollow actinally, pentagonal at the margin, which is slightly tumid. Test suddenly raised at the inner third of the petals to the apex and depressed around the distal ends of the petals. Petals unequal, the antero-lateral being the narrowest; all are slightly tumid. The costæ carry small miliaries, and sometimes one or more larger tubercles resembling those of the interporiferous area. The anus is far back and submarginal. Great variation in shape and in the size of the petals is noticed, and also in the outline of the test.

Locality. Arenaceous series or Miocene: about a mile east of Goir, near Narainsir; river east of Sújapúr; near the south bank of the river from Teyra; Falora river, near Bábúa Hill; Bábúa Hill. Survey-numbers C 166, C 024, C 043 *a*, C 043 A f, C 156, C 153.

Illustrations of the Species in Plate X.

Fig. 5. Abactinal view of test: natural size.
6. Costæ and pores: magnified.
7. Actinal view of a specimen: natural size.
8. Diagram of section.
9. Needle-pillars: magnified.

2. Clypeaster Waageni, *Duncan & Sladen*. Plate XII, Fig. 13.

The test is thin, very depressed, slightly swollen at the rosette, and slightly depressed at the ends of the petals, is longer than broad, broadest posteriorly, a long pentagon in shape, sharply rounded in front, faintly reenteringly curved at the sides and on the median line posteriorly; angles bluntly rounded.

The petals are very slightly tumid, broad, long, and widely open; the interporiferous areas are much wider than the poriferous zones. The odd ambulacrum is the narrowest, and is longer than the antero-lateral, and equal to the posterior pair in length: its poriferous zones become narrow distally and show no tendency to close; whilst the interporiferous area is nearly three times as broad as a poriferous zone. The poriferous zones of the lateral ambulacra diminish in breadth distally, are widely open there, and the last three pairs turn slightly away from the direction of the median line of the broad interporiferous area. The very broad and long posterior ambulacra are also open. The ornamentation of the interradia is close and small, and that of the ambulacra closely resembles it. The costæ carry a row of tubercles of the same dimensions as those beyond.

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* Grant, Geol. Trans. 2nd ser. vol. v. part 2, tab. 24, fig. 26.

Length 67 millim., breadth 55. Length of odd petal and of postero-lateral 20 millim., of antero-lateral 17 millim. Breadth of odd ambulacrum 10 millim., of antero-lateral 11, and of posterior 11·5.

Locality. Kachh. Miocene series; about a mile east of Goir. Survey-number C 043 A f.

Illustration of the Species in Plate XII.

Fig. 13. Abactinal view of the test: natural size.

3. Clypeaster Goirensis. Plate XII, Figs. 14 & 16.

The test is depressed, longer than broad, very slightly elevated at the rosette, irregularly pentagonal in outline, broadest on a line with the antero-lateral ambulacra, narrowest in front of that line. The posterior angles are truncated, and there is a slight reentering curve at the sides and posteriorly. The petals are tumid, long, broad, widely open; the poriferous zones are broad, become narrow suddenly distally, and the terminal pairs are directed outwards; and the interporiferous areas are more than twice as broad as a poriferous zone.

The odd ambulacrum is of the same length as the posterior, but is the narrowest of all in its area and zone. The antero-lateral ambulacra are the shortest, are broader than the odd one, and are very nearly as broad as the postero-lateral; these last are as long as the odd one, and are the broadest of all. The ornamentation is small and crowded, and the costæ carry tubercles in a single row, which are of the same size as those in the interradia and interporiferous areas close by. Near the margin the ornamentation is coarser.

Length 74 millim., breadth 65. Length of odd and posterior ambulacra 20 millim., of antero-lateral 17·5 millim. Breadth of odd petal 12 millim., of antero-lateral 13, and of postero-lateral 13·7.

Locality. Kachh. Miocene series; about a mile east of Goir. Survey-number C 043 A f.

Illustrations of the Species in Plate XII.

Fig. 14. The test from above: natural size.
16. The terminal pores of a poriferous zone: magnified.

Genus ECHINODISCUS, *Breynius*, 1732.

This genus, under the careful study of Alex. Agassiz, has absorbed the genera *Lobophora* and *Amphiope*.

The test is much depressed and thin; the anterior edge is rounded, and the posterior is truncated. There are two lunules or cuts corresponding to the posterior ambulacra. Ambulacral petals small and well defined. Four genital pores. Lower surface flat, and the ambulacral furrows ramify but little towards the edge. Anus near the posterior edge. The greater part of the interior is occupied by a calcareous network rising into pillars for more than half the distance between the edge and the actinostome*.

In the Miocene series of Kachh there are some imperfect specimens of a small member of this genus; but they are sufficiently well preserved to give specific characters, which show that they differ from, and yet are closely allied to, *Echinodiscus biforis*, L. Agassiz, sp., from Mozambique, the Red Sea, and Java.

1. Echinodiscus Desori, *Duncan & Sladen*. Plate XII, Figs. 7-10.

The test is very thin, broader than long, broadest on a line with the distal ends of the posterior ambulacra; it is narrower and rounded in front and broadly rounded behind. Actinally, the test is flat and the actinostome is very small and nearly central; abactinally there is a very faint projection of the rosette and apical system, which is subcentral or slightly posterior.

The anterior odd ambulacram is the longest, and is narrower than the antero-lateral petals, which are the broadest. The posterior petals are broader and shorter than the anterior, and smaller altogether than the antero-lateral petals. The petals are short and closed, and the rosette is small on the whole. The poriferous zones are broad, and their greatest breadth is at their outer third; the interporiferous area is about the breadth of one of the poriferous zones.

The apical system is large in comparison with the petals, and there are four generative pores: the front pair are distinct from the others, and are slightly closer together than are those of the hinder pair. The posterior pores are external to the position of the antero-lateral ocular pores.

The lunules behind and in a line with the posterior ambulacra are in ellipses, whose long diameter is not quite three times that of the minor.

Actinally the grooves are broad and shallow; they bifurcate close to the mouth, curve symmetrically, and enclose long elliptical spaces, and give off a side branch near the edge. Each groove has a raised ridge on its floor near the peristome, which ends in a slight swelling perforated by two lenticular pores.

The peristome is longer than broad, and the interambulacra are slightly raised at its edge, the posterior being the broadest.

Locality. Miocene series of Kachh: three miles north-west of Kayári, near Narainsir. Survey-number C 038 f.

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* See Alex. Agassiz, 'Revision of the Echini,' p. 531.

Illustrations of the Species in Plate XII.

Fig. 7. The abactinal surface: natural size.
8. The actinal surface: natural size.
9. Plates near a lunule: magnified.
10. Side of the peristome: magnified.

Suborder ATELOSTOMATA.

Family CASSIDULIDÆ.

Subfamily ECHINOLAMPINÆ.

Genus ECHINOLAMPAS, *Gray*, 1825.

The diagnosis of this genus has been given and considered on a former page.

The Miocene series of Kachh contains numerous specimens of a species of *Echinolampas* which is closely allied to the recent species.

The measurements indicate that in height, breadth, and length the forms are nearer *Echinolampas Hellei* than *Echinolampas oviformis*; but the apical system is more excentric anteriorly than in either of the living species, and the structure of the peristome differs. Under the circumstances, we place the forms provisionally in a new species.

1. Echinolampas Indica, *Duncan & Sladen.* Plate IX, Figs. 1–10.

The test is long, broadest on a line with the end of the posterior poriferous zone of the posterior ambulacra, not very high, swollen at the margin, very broadly curved anteriorly from the small, very excentric in front, apical system; it slopes very slightly behind for some space, and then more so to the slightly projecting posterior edge, which overhangs the periproct. Behind the position of the greatest breadth the test is somewhat nipped-in. On the actinal surface the angularity produced at the greatest breadth is evident; the surface is slightly convex from the margin to near the peristome, which is in a slight yet definite depression. The peristome is rather large and pentagonal; it is open and deep, and its front lip is on a line with the apical system. The bourrelets are small, low, broad, and are covered with a smaller ornamentation than just beyond, and it resembles that of the walls of the peristome. The phyllodes are petaloid and are in very slight depressions, and the doubling of the pores and the central line of minute tubercular ornamentation are evident. The anterior odd one is continued forwards, and has alternate large tubercles succeeded by smaller and more numerous ones near the ambitus.

The apical system is small, button-shaped, projecting, and there are four generative pores; madreporic body central.

The ambulacra are petaloid except the odd one; the poriferous zones are narrow, and the interporiferous areas wide and nearly flush with the test.

The anterior odd ambulacrum is much the shortest, does not close, and its breadth is less than that of the other petals, but approaches that of the postero-lateral pair. The left-hand poriferous zone is slightly the shortest.

The antero-lateral ambulacra are very nearly transverse and broader than the others; they are lanceolate near the apex, but near the margin the anterior poriferous zone (the shorter of the two) turns backwards, whilst the posterior and longer continues its path, turning very slightly posteriorly when nearer the margin than the other.

The postero-lateral ambulacra, narrower than the antero-lateral, are slightly the longest, for their anterior poriferous zone is continued on beyond the posterior by ten or twelve pairs of pores, and this part of the zone tends to turn slightly forwards at the end. The pairs of pores of the ambulacra are rather wide apart. The ornamentation of the interporiferous areas is very close, and it is in transverse linear series in lateral ambulacra.

Behind the apex the test is much less tumid than in front; and the ornamentation is small, close, and uniform over the whole abactinal surface.

The periproct is submarginal and rather obliquely placed; it is elliptical and elongated transversely, and is visible from behind in young specimens.

The ornamentation of the interradia is crowded and small, widest near the apex and ambitus.

The ornamentation on the actinal surface is nearly twice the size of that above, as well as more distant and distinct.

Measurements of type:—Length 55 millim., breadth 49, height 30.

Ditto of a large form:— „ 65 „ „ 56, „ 34.

Distance of apical system from the front in type 11 millim., and in the large specimen 15 millim.

Relative dimensions:—Length 1, to breadth 0·89, to height 0·54.

„ 1, „ 0·86, „ 0·52.

Locality. Miocene series of Kachh: Wamúti. Survey-numbers C 190, C 190 f.

Illustrations of the Species in Plate IX.

Fig. 1. Abactinal view: natural size.
2. Side view.
3. Actinal view.
4. A specimen with narrower petals.
5. Abactinal view of the same.
6. Apical system, magnified, of Fig. 1.
7. Peristome: magnified.
8. A variety: abactinal view.
9. A variety: actinal view.
10. Part of a phyllode: magnified.

2. Echinolampas Wynnei, *Duncan & Sladen*. Plate IX, Figs. 11, 12.

The test is long, narrow, ovoid, narrower behind, depressed, much more tumid abactinally anteriorly than posterior to the excentric in front apical system. The slope is sudden to the tumid margin in front and also to the sides from the apical system, which is at the highest point, and the slope is more gradual posteriorly.

The profile from the front is bluntly angular above, curved at the sides at the ambitus, and narrowed and level inferiorly. The margin is tumid except posteriorly in the median line and on either side of it, where the test is nipped-in somewhat. There is a slight angularity on the margin, far back in the lateral interradia.

The apical system, which is at the highest point, is excentric in front, and is well developed. The ambulacra are unequal, very slightly raised, the narrow poriferous zones being sunken. The odd ambulacrum is short, narrow, and open. The antero-lateral ambulacra are exceedingly broad and short, but longer than the odd one; their anterior poriferous zone forms a bold curve convexity forwards, and the posterior zone, nearly equally curved at first, has the convexity backwards; it is longer than the anterior by many pairs of pores, and these curve in the opposite direction. The poriferous zones have the pairs of pores rather widely apart, and the costæ are stout and carry a row of granules. The pairs diminish in breadth towards the end, and become more distant. The pores are large, and the inner series are more circular in outline than the outer.

The posterior ambulacra are the longest, but they are not so wide as the lateral; they are petaloid and broad except where the posterior zone tends to approach the other, which is prolonged nearer the margin. The ornamentation of the interporiferous areas is crowded and small, and hardly differs from that of the interradia close by.

Actinally the test is swollen between the rather sunken peristome and the margin. The peristome, excentric in front, is pentagonal, not much broader than long, and is deep, with granular walls. The bourrelets are well developed, and the lateral are the smallest and the most projecting; the posterior is the widest, but does not project so much as the anterior; their rim projects, and is ornamented with small tubercles resembling those of the peristome-wall.

The phyllodes are petaloid and somewhat sunken; two pores are at the peristomial end, and beyond is a succession of double pores, and there are pittings in the median line of each phyllode for sphæridia. The periproct is elliptical and transverse, and opens downwards and backwards; it is inframarginal, transgressing on the margin, and is visible from behind. The ornamentation of the actinal surface is close and crowded, middle-sized at the margin, larger nearer the peristome, and largest in the interradia close to the phyllodes.

Length 49 millim., breadth 41, height 22.

Relative dimensions:—Length 1, to breadth 0·83, to height 0·44.

Locality. Miocene series: Wamúti, Kachh. Survey-number C 190 f.

Illustrations of the Species in Plate IX.

Fig. 11. The test, from above.

12. Actinal view.

3. **Echinolampas sphæroidalis**, *d'Archiac.* Plate XII, Fig. 6.

Several much-fractured specimens of this species are amongst the collection from the Miocene series of Kachh. They agree with the description given in 'Les Animaux fossiles de l'Inde,' p. 210, and plate xiv, figs. 6 *a*, *b*.

We figure the abactinal surface of a specimen from "Stream-course near Pipúr, bordering the tidal flats." Survey-number C 044 f.

Illustration of the Species in Plate XII.

Fig. 6. The abactinal surface: natural size.

It is interesting to find that this and the next so-called Nummulitic species belong to the Miocene fauna.

4. **Echinolampas Jacquemonti**, *d'Archiac.*

Some indifferent specimens are in the Miocene series.

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus MOIRA, *A. Agassiz*, 1872.

Moera, *Michelin*, 1855.

Desor, in his 'Synopsis des Echinides,' gives the following definition of the genus (page 394):—

Urchins of moderate height, tumid, ovoid, well characterized by their very narrow ambulacra, which resemble fine deep slits starting from the summit, and being closely surrounded by a peripetalous fasciole in the form of a smooth band. A lateral fasciole exists as in *Schizaster*. There are two generative pores.

The fossil species, *Moira lachesis*, Girard, is found in Postpliocene deposits in South Carolina. It is, however, a variety of *Moira atropos*, A. Agassiz,=*Spatangus atropos*, Lamk., a recent form, found down to 80 fathoms from the shore, West Indies to North Carolina, and this is probably its northern limit.

A recent species, found on the Californian coast, is *Moira clotho*, Mich. Alex. Agassiz notices that it is most closely allied to *Moira atropos*, and indeed the distinction is hardly specific. But this species is of importance because another recent one, *Moira stygia*, Lütk., is well differentiated, and inhabits the Red Sea and Zanzibar coast. It is possible to compare a fossil form from the Miocene of Kachh, which is found in considerable numbers at Wamúti, with these recent forms. The result is very interesting, for it is clear that the species about to be noticed has some of the characters of *Moira stygia* and some of those of *Moira atropos* and its variety.

1. **Moira antiqua**, *Duncan & Sladen.* Plate VIII, Figs. 1–6.

The test is high, slopes sharply from the raised keel in the odd interambulacrum to the anterior margin, and more decidedly backwards to the posterior truncation, which is curved, concavity backwards, and ends below in the prominent termination of the plastron. The marginal outline abactinally is heart-shaped and pointed behind; and actinally the breadth is greatest behind. The apical system is behind the centre and in front of the narrow raised keel of the posterior interambulacrum. Two generative pores are present.

The anterior odd ambulacrum, widest and very deep in front of the apical system, narrows and shallows towards the margin, and is continued over it close to the peristome as a decided groove with a flat floor. The pairs of pores are scanty in this last part of the ambulacrum, but are numerous and close in the deeply-sunken portion. The anterior lateral ambulacra are long, make an angle of 90°, are slit-like, and the sides are widest apart distally. The direction of the narrowest part, which is close to the actinal system, is more from behind forwards than further out. There is no overlap of the edges or occlusion.

The posterior lateral ambulacra are much shorter than the anterior, form an angle of about 45°, are straight, narrow, and deep.

The peristome is large, transverse; the anterior lip is slightly convex anteriorly, and the posterior projects below its level. Large depressions for pores occur in the course of the antero-lateral ambulacra near the mouth, and also at the origin of the odd ambulacrum. The posterior ambulacral spaces are narrow near the mouth, and they broaden posteriorly; they are finely granulated. The plastron is narrow, projects downwards, is convex from side to side, and very slightly so from before backwards; its ornamentation is regular, and radiates from the posterior projection to the front, and the tubercles are large in front and gradually diminish in size posteriorly.

The periproct is situated high up in the posterior truncation, is rather small, and is elliptical in outline. The peripetalous fasciole is narrow, and clings to the edges of the groove-like ambulacra; and the lateral fasciole is very linear, and passes downwards and backwards, reaching the projection at the bottom of the truncation and crossing far below the periproct. The upper part of the truncation rather overhangs the lower.

Length 26·5 millim., height 21 millim., breadth 25 millim.
„ 19 „ „ 15 „ „ 20 „

Locality. Miocene series of Kachh: Wamúti. Survey-numbers C 190, C 190 f. Abundant.

Illustrations of the Species in Plate VIII.

Fig. 1. The test of a moderate-sized specimen: side view.
2. Posterior view: natural size.
3. Abactinal view of another specimen.
4. Abactinal view of another specimen.
5. Abactinal view of a large specimen.
6. Outline of a small specimen: actinal view.

Genus BREYNIA, *Desor*, 1847.

Large Urchins well characterized by the presence of peripetalous, internal, and subanal fascioles. There are large tubercles with deep scrobicules limited by the peripetalous fasciole, but not in the posterior interambulacrum. The internal fasciole crosses the four petals, and their pores within its area differ from those without and may disappear.

1. BREYNIA CARINATA, *d'Archiac & Haime.* Plate X, Figs. 1–4.

There are two specimens in the collection from Kachh which are sufficiently well preserved to enable their identity with *Breynia carinata*, d'Archiac & Haime, to be established*. Unfortunately the typical specimen in the collection of the Geological Society of London does not show the correct position of the crossing of the internal fasciole anteriorly.

Messrs. Medlicott and Blanford† give an excellent figure of the species, drawn by Wynne and Fedden (diminished one half); and they indicate the correct shape of the area within the internal fasciole, making it elongate, and also show for the first time distinctly the minute pores of the lateral and posterior ambulacra within the internal fasciole. These are clearly seen in the typical specimen in the Museum of the Geological Society.

In the specimens from Kachh the test is decidedly nipped-in behind the posterior ambulacra. The number of large tubercles increases with the dimensions or growth of the test, and the area within the internal fasciole is long, regularly arched in front, and more angular behind.

The pores of the lateral and posterior ambulacra are visible, and those of the odd ambulacrum are continued to the crossing of the fasciole. The large pairs of pores of the ambulacra are separated by costæ which are beautifully granular. The large tubercles stand up from the depths of their scrobicules, are conical, small at the top, perforate and crenulate. The periproct is elongate transversely, and the more or less cordiform subanal fasciole environs tubercles placed in very regular transverse and oblique series separated by grooves, on which, near the fasciole, are the ambulacral pores.

The peripetalous fasciole does not enter the space between the ambulacra, and includes the great tubercles.

Locality. Miocene series: near Bair (not found in place), and near Bútta, east of Ierá. Survey-numbers C 046, C 067.

Illustrations of the Species in Plate X.

Fig. 1. The test, abactinal view.
2. The test, posterior view, showing subanal fasciole.
3. Abactinal view of a large specimen.
4. Apical system: magnified.

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* *Op. cit.* p. 216, tab. xv.

† *Op. cit.* plate xvi, fig. 9.

The type of the genus *Breynia* is the recent *Breynia Australasiæ*, the *Spatangus Australasiæ* of Leach, from South Australia. A second species described by Gray, 'Catalogue of Echinida,' is from Western Australia. His description, however, is difficult to understand, as he says there are tubercles on the posterior interambulacrum. Probably this is a misprint for anterior. The real and only difference between this and the southern form (which is also now found in the Chinese and Japanese seas and in Torres Straits) is that the number of tubercles is greater in the western form. Alex. Agassiz does not recognize this second species, however.

The recognized species is carefully described by Alex. Agassiz in his 'Revision of the Echini;' and he notices the complete obliteration of the inner pores of the lateral and posterior ambulacra within the internal fasciole, and the paucity of great tubercles on either side of the anterior ambulacrum.

Genus TROSCHELIA, gen. nov.

The test is long, high, oval, notched in front, truncated behind. Apical system excentric in front; madreporic passing between the posterior ocular plates. Lateral ambulacra in very deep grooves; pores large; poriferous zones not closed; inner pores of antero-lateral ambulacra small. Peristome excentric in front, broader than long, posterior lip well developed. Periproct high up in the truncation. Large sunken tubercles in the interradia, except the posterior. A peripetalous fasciole passes between the great tubercles on the lateral interradia. A subanal fasciole well developed.

1. Troschelia tuberculata, *Duncan & Sladen.* Plate VII, Figs. 9–12; Plate XI, Fig. 5.

The test is irregularly oval in outline and largest anteriorly; abactinally it is rounded in front, slightly notched at the margin by the anterior groove, broadest behind the apical system, which is excentric in front, nipped-in posteriorly, and truncated behind, the truncation sloping gently from above downwards and forwards. The test is longer than broad and broader than high, and the height is one half of the length; it is generally tumid, the transverse outline of the abactinal surface being nearly hemispherical. The margins are rather sharply rounded and the actinal surface is generally slightly convex, except at the narrow flat plastron, the posterior extremity of which projects decidedly downwards. The highest point of the test is nearly central and behind the apical system, the slope is gradual posteriorly, and there is a bold curve anteriorly.

Length of test 64 millim.; breadth 54 millim.; height 32 millim. The length to the breadth 1 : 0·843; the length to the height 1 : 0·5.

The apical system is far in front and slightly posterior to the third of the length from the anterior margin. The peristome is also excentric and in front, but it is slightly posterior to the position of the apical system. The periproct is at the top of the posterior truncation and just below the ending of a rounded-off keel; it is large, elliptical in outline, elongate nearly vertically, and is partly visible from the actinal surface, but not from the abactinal.

The apical system is situated in front of a broad keel in the odd interambulacrum, and behind a flat surface which leads in front to the narrow shallow groove for the anterior ambulacrum; it is small. There are four generative pores, of which the posterior pair are the largest and widest apart; the anterior pair are close to the posterior; and the madreporic body extends between the posterior pair and posteriorly to them, being larger than the area included by the pores.

The odd anterior ambulacrum in the groove has a broad floor; and the pores, elongate, very visible, and few in number, are on the slope of the broad keel-like eminences which bound the groove. The pairs of pores are wider apart antériorly.

The anterior pair of ambulacra are long, nearly transverse in direction, and are placed in wide and deep grooves, which become flush with the general surface at the outer end of the poriferous zones, not far from the margin. The grooves are broader and deeper than that which includes the odd ambulacrum: they diminish in breadth externally, and the anterior edge is slightly convex to the front, the posterior being straight. The interporiferous area is narrow and finely granular, and is on the base of the groove; and the poriferous zones are broad and partly on the flanks of it. The pores within the groove are very large, nearly circular in outline, those of each pair being separated by a narrow process and conjugate, and there are about twelve pairs in each zone. But nearer the apical system, at the commencement of the groove, there are, in each zone, a pair of small pores and four pairs of almost microscopic ones, ending close to a minute ocular pore. The poriferous zones do not curve together at the outer extremity of the groove, and the petal is not closed; the peripetalous fasciole is in close contact with this part of the ambulacrum.

The posterior pair of ambulacra are the longest, are in deep grooves, which are narrower than those of the antero-lateral pair; they diverge at a very acute angle and are close together, being separated by the narrow, convex, keeled interambulacrum, whose extreme breadth is not more than twice that of the grooves. These ambulacra are nearly straight; but towards their ends they curve slightly forwards, become flush with the test, and are bounded by the fasciole. The petals do not close. There are about eleven or twelve pairs of large pores within the groove, and the interporiferous area is narrow. Nearer the apex there are a few very small pores.

The anterior interradials are roundly keeled at the anterior groove, tumid elsewhere, and pass into the rounded margin. The ornamentation on top of the flat keel on either side of the anterior groove, just in front of the apex, is of close rows of flat tubercles in sets of four, and they become irregular and smaller towards the front and also near the antero-lateral ambulacra. On the slope of each interradium in front are three irregularly placed groups of large tubercles sunken in deep scrobicules and adherent to one side of them. The first group is a solitary tubercle, which may be flanked by two smaller ones; the second, inferior to the first and separated by the fasciole, is a long irregular linear series of six tubercles; and the third, still nearer the margin, consists of a small group of tubercles near the groove, and of a linear series extending below the line of the antero-lateral ambulacrum.

The lateral interradia are marked with some twenty large tubercles of the same character as those of the anterior interradials; they vary somewhat in size, and the smallest are the lowest. They are in irregular rows, and the uppermost set is separated from the others by the peripetalous fasciole. Occasionally some of the tubercles are close to the distal end of the poriferous zone of the posterior ambulacra.

The junction of one side of the tubercles with the test in which the scrobicule is sunken is very evident; they rise but little, or not at all, above the level of the test, and have a minute mamelon which is perforate and crenulated. The ornamentation between these great tubercles is very closely packed, and consists of small flat tubercles larger than miliaries, with hardly any space between them.

The posterior interradium, convex from side to side, keeled anteriorly and truncated posteriorly, has no large tubercles upon it, and the ornamentation resembles that of the other interradials.

The peristome is transverse, slightly sunken, with a well-developed posterior lip. The anterior groove, after notching the margin of the test, is lost, and does not lead to the peristome. A very narrow and slightly projecting posterior ambulacrum leads on either side of the plastron to the peristome in front, and to the strongly ridged arched portion of the ambulacrum within the subanal fasciole behind. This narrow band has no tubercles, and they are small on the ridge.

The plastron is narrow and is covered with small tubercles on flat, raised scrobicules, and their size dimiuishes towards the dependent projection, which is crossed by the fasciole.

The rest of the inferior surface beyond the fasciole and the plain band of the posterior ambulacra is profusely tuberculate, the dimensions of the tubercles increasing from the margin inwards. Usually the tubercles project from the edge of flat scrobicules with circular or elliptical margins; but occasionally the scrobicule is sunken in front, and a miniature of the large tubercles of the abactinal surface is produced.

The subanal fasciole is strongly developed, and is on the slope of a considerable bent ridge placed on either side of the test. The fasciole crosses over to the opposite side between the peristome and the depending part of the plastron, and forms above a curve, concavity upwards, which is situated far below the anus. Within the area limited by the fasciole are some pores of the ambulacra and some distinct tubercles in rows; these tubercles diminish in size towards the median line, and are placed on slightly raised, flat, elliptical or circular scrobicules.

There is a concave space below the anus, and it is limited below and at the sides by the ridge for the subanal fasciole.

There is a narrow and very sinuous peripetalous fasciole; it can be seen passing round the end of the antero-lateral ambulacra and curving upwards and forwards between the series of large tubercles on the anterior interradia to cross over to the opposite side. Posteriorly it passes upwards and backwards, separates the upper tubercles from those nearer the margin, and reaches the edge of the posterior ambulacra; it turns round their outer terminations and crosses over the posterior interradium rather far back.

Locality. Kachh: stream-course north-west side of Hikelu Hill. Miocene series. Survey-numbers C 061 B f, C 061 (*b*).

Illustrations of the Species in Plate VII.

Fig. 9. Abactinal view: natural size.
10. Actinal view: natural size.
11. Part of the ornamentation near the anterior ambulacrum: magnified.
12. A tubercle: magnified.

Plate XI.

Fig. 5. The apical system, showing the small pores.

Genus EUSPATANGUS, *Agassiz*, 1847.

1. Euspatangus patellaris, *d'Archiac & Haime.* Plate XII, Figs. 3–5.

A specimen of this beautiful species, unfortunately broken (as is the type) posteriorly, is in the collection from the Miocene series of Kachh. It coincides with the drawing and description given by MM. d'Archiac and Haime (*op. cit.* p. 217, plate xv, figs. 6 *a*, 6 *b*); but there are some points of detail which may be added. The large tubercles in sunken scrobicules have narrow conical bosses and very small mamelons, which are perforate and crenulated. The ornamentation is very pronounced, of different-sized small tubercles mixed without much order. The fasciole is narrow but distinct, passes over the front along the margin, and is more lateral than peripetalous. The plastron on the actinal side is broad, and with the ambulacra forms a large portion of the test; it is nearly plain in its ornamentation. The anterior margin is slightly notched, and the furrow is continued over to the mouth.

Locality. Miocene series of Kachh: Wahior stream near Chiropira. Survey-number C 055 B.

Illustrations of the Species in Plate XII.

Fig. 3. Actinal surface; natural size.
4. Odd ambulacrum: magnified.
5. Fasciole and ornamentation: magnified.

Amongst the collection from Kachh is a specimen the locality of which is unknown:—

Genus SCHIZASTER.

1. Schizaster Granti, *Duncan & Sladen.* Plate VI, Figs. 8–12.

The test is oval, broad and rounded in front, the greatest breadth being behind the antero-lateral ambulacra, and narrow almost to a point behind; it is depressed and is very slightly highest on the posterior keel. Length 30 millim., breadth 26·5 millim., height 19·5 millim. The test, rather flat above, slopes gradually to a narrow, tumid, slightly notched anterior margin; the low and only slightly convex keel of the posterior interradium slopes backwards and overhangs the posterior truncation of the test; and the sides are everywhere tumid. The posterior part is roundly truncated and is reenteringly curved, being concave from above downwards; the periproct, high up and large, is visible on an actinal view. Actinally the test is generally convex, and especially from side to side over the plastron.

The apical system is excentric and behind the centre, and the peristome is far in front. The anterior odd ambulacrum is in a deep groove with nearly vertical sides and about twelve pairs of pores placed at the angle of the floor and wall, and they are moderately distant. The pores of each pair have a tubercle between them, and are in the midst of a granular surface, which also covers the floor of the groove. Higher up on the flanks of the groove tubercles, small and not very close, are seen. In front the pairs of pores become very rare, the groove widens and almost ends, and there it is traversed by the fasciole, whose curve is convex anteriorly. Beyond, the groove is faintly traced to the peristome.

The antero-lateral ambulacra are moderate in length, narrow, in deep grooves, pointed at the distal end, and curved, convexity forwards and inwards; they form an angle of 90°.

The interporiferous areas are narrower than the poriferous zones, which are on the slope of the sides of the groove. The pairs of pores are distant, separated by broad low costæ, on which is a narrow row of miliaries or a simple ridge. The pores of the pairs are large, obliquely placed, elliptical, and the outer are the longer; often a ridge or rim surrounds a pore. There are about 22 pairs of pores.

The trace of the relics of the other ambulacra shows them to have been rather wide apart and short.

A well-developed peripetalous fasciole clings to the ambulacra in the lateral interradia; it then turns round the antero-lateral ambulacra, barely closing them, so close are the distal pairs of pores. The fasciole then passes almost directly inwards to reach the keel of the anterior groove, and passes forwards almost to the ambitus, and then crosses. A lateral fasciole leaves the peripetalous one, and dips down to reach the posterior part of the tuberosity at the end of the plastron; and it crosses beneath the periproct above the tuberosity and below the concave, hollow, and highly ornamented infraperiproctal area. The peristome is crescentiform, and the plastron is large. The areas of the posterior ambulacra on either side of the plastron are curiously granulated. The ornamentation is generally small, and increases very regularly in size at the anterior margin, being largest below in front of the peristome. The tubercles are low, and have a perfect or imperfect raised scrobicular circle. The keels of the anterior interradia are moderately developed, especially posteriorly.

Locality. Geological position doubtful: in Alrása, Western Kachh. Survey-number C —— ?

Illustrations of the Species in Plate VI.

Fig. 8. The test, abactinal view: natural size.
9. The test, actinal view: natural size.
10. Anterior ambulacrum: magnified.
11. Distal end of an antero-lateral ambulacrum: magnified.
12. Tubercles: magnified.

This species is common in Kattywar, in the Miocene series, and is the commonest Spatangoid in the Gáj series (Miocene) of Sind. It will be noticed amongst the collection from those localities.

VII. *Remarks on the Faunas. Nummulitic Species of Kachh.*

The variety of the species *Arachniopleurus reticulatus*, nobis, which was described and figured in our work on the Fossil Echinoidea of Western Sind, is almost worthy of being called a new species, were it not evident that all the species of Temnopleuridæ with the raised ribbing of the plates vary in this ornamentation during growth and individually. The form links together the faunas of the Nummulitic series of Kachh and Sind, although no other Ranikot species is distinguishable in the higher horizon of Kachh whence the fossil was derived. Clearly the Ranikot series of Sind is below the main Nummulitic limestone, to which the lowest marine fossiliferous Tertiary beds of Kachh belong. The affinities of the genus with *Glyphocyphus*, *Dictyopleurus*, and the false Temnopleuridæ, or those without true pits*, are evident, and also with *Paradoxechinus*, Laube, of the Australian Tertiaries. No other member of this or of the true Temnopleuroid group is as yet known from the Nummulitic series of Kachh.

The species of *Clypeaster* is at once known by its very open ambulacra and receding terminal part of the poriferous zones. The needle-pillars are visible at a fractured spot, and there is no doubt about the genus. It is the earliest example of the genus in the Indian Nummulitic.

We have enlarged upon the genus *Amblypygus* in describing the two well-marked species from Kachh. The position of the anus, the oblique peristome, the intercalated ambulacral plates, and the double series of pores, which is continued over the margin to well within the peristome, are generic and characteristic. The modern genus *Echinoneus* is closely allied, and the nature of the interradial plates around the peristome is the same in both genera, and were it not for the presence of a remarkable tuberculation, should come under the genus *Amblypygus*. The Kachh forms do not resemble those of Sind †, although the alliance is closer than with the species described by de Loriol from Egypt. The great height in relation to length and the pentagonal outline are distinctive and characterize the Kachh form.

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* Duncan, "Morphology of Temnopleuridæ," Journ. Linn. Soc., Zool. xvi. p. 343.

† Khirthar series.

The genus is not found in the Ranikot series of Sind, but in the higher and main Nummulitic limestone of the Khirthars.

Several species and a variety of the genus *Echinolampas* are described from the Nummulitic series of Kachh. The commonest are high, long Conoclypoid-looking forms, eminently suggestive of Egyptian affinities. The beautiful forms described by de Loriol from the Nummulitic of Egypt and Lybia, and named by him *Echinolampas Fraasi* and *Osiris*, are closely allied to the Kachh species, which, however, do not appear to have any great affinities with the Echinolampads from Sind. Amongst the more depressed forms from Kachh one resembles *Echinolampas discoideus*, d'Archiac, but it is nevertheless distinct.

Amongst the flat and oval species is *Echinolampas Vicaryi*, d'Archiac; and probably it was from Kachh that the typical specimen came.

Cotteau's genus *Peripneustes* is represented in the Nummulitic of Kachh; and we have noticed the affinities of the genus to *Euspatangus* and *Macropneustes* in the description of the species, which stands rather alone. It gives a Nummulitic facies to the collection, which is intensified by the presence of two large depressed *Hemiasters*, *Linthia*-like in shape; they have peripetalous fascioles only.

Another *Hemiaster*, *H. carinatus*, nobis, is mimetic of the shape of *Schizaster Baluchistanensis*, d'Archiac, but has two generative pores, a peripetalous fasciole only, and great keels on the anterior and posterior interradia. It is a very marked form.

The *Schizaster* which has given much trouble to some students of the European Nummulitic, and which has the not very euphonious name *Beloutchistanensis*, d'Archiac (and which may be spelt *Baluchistanensis*), is one of the types described by d'Archiac and Haime from the Hala range—a geographical fallacy, but meaning the hill-country of Western Sind. The typical specimens were so rolled that no ornamentation could be seen, and the position of the fascioles is open to doubt. The shape, however, is peculiar. The great height of the posterior keel adds to the general height of the hinder part of the test, the ambulacra are very different in size, and there are four generative pores, the two anterior being on a line with the anterior and antero-lateral ocular pores. The actinal plastron is rather convex.

A variety is found in Kachh, in the Nummulitic series, but it is not a common form.

The *Euspatangi* of the Nummulitic deposits of Kachh have given much trouble, on account of their resemblance to *Maretiæ*. Indeed it appears that the genus which was the last defined must be absorbed by that which first attracted the notice of Agassiz. There is no generic distinction between *Euspatangus*, Agass., and *Maretia*, Gray, except in the existence of a peripetalous fasciole in the first named. In some *Euspatangi* the fasciole is well developed, in others it is seen with difficulty, and in the form *Euspatangus affinis*, Duncan and Sladen, from Kachh, only a vestige exists, about 3 millim. in length. On the other hand, *Maretia planulata* has occasionally a partial fasciole, and a fossil form from Australia has it distinctly. It is in our opinion impossible to form an intermediate subgenus, and unreasonable to separate forms generically because of one very variable structural peculiarity, which is not of much physiological importance.

In the well-known type *Euspatangus rostratus*, d'Archiac, from Kachh, no peripetalous fasciole exists; it has all the characters of a *Maretia* with a large anterior notch. But in Sind, as will be noticed in our memoir on the Khirthar series, the presence of a faint and short fasciole is evident. Hence we call these forms *Euspatangi*, and not *Maretiæ*.

The truly Nummulitic Echinoid fauna of Kachh has no affinities with those of the Infra-Trap and Ranikot series of Sind; it is to a considerable extent Egyptian in its facies, but the species which give the idea of likeness are representative, not identical.

Only *Echinolampas Vicaryi*, *Schizaster Baluchistanensis*, and *Euspatangus rostratus* have been previously observed in Indian Tertiaries; they are species which were described from Sind by MM. d'Archiac and Haime, and the first two are truly Nummulitic.

Amongst the forms noticed by Grant and described in a very short memoir by Sowerby, from Kachh*, one called by the latter (but not described) *Galerites pulvinatus* is an *Amblypygus*; another, called *Clypeaster*, is an *Echinolampas*, and probably *E. Vicaryi*, d'Archiac; a second *Clypeaster*, termed *varians*, but not described, only figured, is one of the tall forms of *Echinolampas* described in this memoir. Sowerby's *Spatangus acuminatus*, Goldfuss, is *Schizaster Baluchistanensis*, d'Archiac.

Remarks on the Forms from the Oligocene Series with Orbitoides.

The number of species is very small, and *Clypeaster* predominates as a genus.

There are four specimens of different species or varieties of the genus *Clypeaster* in the collection of the Geological Society of London, which were noticed by MM. d'Archiac and Haime and by Grant. Two are considered by the first named authors to be varieties of *Echinanthus profundus*, and one is called by them *Echinanthus Halaensis*. Capt. Grant and Sowerby appear to have been struck with the elongate form and deep actinal surface of the fourth form, which, however, is in such a condition that we do not propose to deal with it. It is necessary, however, to consider the first three forms, which belong to the genus *Clypeaster*, Agassiz, and not to that of *Echinanthus*.

CLYPEASTER PROFUNDUS, *d'Archiac*, sp. (*op. cit.* p. 207, plate xiii, fig. 14).

In a form called by d'Archiac variety *a*, the length is greater than the breadth, 79 millim. to 62 millim., the margins are moderately thick but not tumid, and the slope upwards of the rosette is slight and to the apex. Irregularly pentagonal, the margin is sharply rounded in front, incurved to the lateral ambulacra, then straight to the truncated posterior lateral angle. The hinder margin is thinner than the front and is slightly incurved.

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* Grant, "Geology of Cutch," Trans. Geol. Soc. ser. ii. vol. v. pt. 2, p. 327.

The anterior odd petal and the postero-lateral are equal in length, and the latter is the broader; the antero-lateral petal is the shortest and narrowest of all, its length being a little less than the odd one, and its breadth also. The ambulacra are slightly tumid and are open distally; the poriferous zones are broadest midway and are rather pointed towards the ends; the inner row of pores forms a regular but slight curve, and there is a slight outward turning at the outer extremity. The interporiferous areas are twice the breadth of a poriferous zone.

Length of odd and posterior ambulacra 23·5 millim.; length of lateral petals 20 millim.; breadth of odd petal 11 millim.; of lateral 10 millim.: of posterior 12 millim.

The variety β of M. d'Archiac is pentagonal, longer than broad, broadest on a line with the lateral petals, and narrowest at the truncated posterior angles. The sides are slightly rounded anteriorly and sharply so quite in front; they are nearly straight, passing backwards and rather inwards behind the point of greatest breadth. The test is thick; and the slope from the apex is more gradual in front than behind it.

The characteristics of the form are the great size of the poriferous zones in the outer third of the petals, the curvature of the line of the inner row of pores, the comparative narrowness of the interporiferous areas in relation to the poriferous zones, and the nearly closed condition of the distal ends of the ambulacra.

Length of test 71 millim.; breadth of test 51 millim.

Length of odd ambulacrum 21 millim.; breadth of odd ambulacrum 12·5 millim.
„ lateral „ 16 „ „ lateral „ 11·75 „
„ posterior „ 21 „ „ posterior „ 12·5 „

Interporiferous area 1½ times as broad as the poriferous zone.

The odd and postero-lateral petals are thus equal in size and are larger than the antero-lateral.

This form is specifically distinct from the variety α.

The third form, *Clypeaster Halaensis*, d'Archiac, is flat-topped, as is well shown by MM. d'Archiac and Haime (*op. cit.* plate xiv); it is rather thick anteriorly and thin behind, pentagonal, longer than broad, broadest slightly in front with straight sides. The following are the measurements:—Length of test 72·5 millim. (a fracture prevents the breadth being known).

Length of odd ambulacrum 20 millim.; breadth of odd ambulacrum 16·5 millim.
„ lateral „ — „ „ lateral „ 11 „
„ posterior „ 20 „ „ posterior „ 12 „

The anterior interporiferous area is 1½ times as broad as the poriferous area, and the width of the interporiferous area of the postero-lateral is twice that of the poriferous zone. The inner line of pores of the anterior ambulacrum is faintly curved, and that of the posterior considerably so; and all the poriferous zones nearly approach at their distal ends.

The fourth species is *Clypeaster depressus*, Sowerby. This is not a Nummulitic form, but it characterizes the Oligocene in Sind and the Miocene in Kachh.

The others have not been found as yet in the Lower Tertiaries of Sind or of Kachh. There are, however, three species of *Clypeaster* in this division of the Kachh Tertiaries; they all have very open petals, and are depressed, yet well-sized forms. As a group they recall, but are specifically distinct from, the series described by Laube from the Vicentin, which includes *Clypeaster Michelini*, *C. scutum*, and *C. regulus* ("Vicentinische Echinodermen," Denkschr. d. k.-k. Akad. d. Wissensch. Bd. 29, Taf. iii. 1868).

A very fine specimen of an *Echinolampas* is in this series, and although only portions of the test are visible, its swollen, high, and long slope are evident. The petals, were they on the same level as the test and slightly narrower, would correspond with those of *Echinolampas globulus*, Laube, and especially with those figured by de Loriol in his last work on Egyptian and Lybian Echini. Considering how variable a species this is, and the general resemblance of the Kachh form to figured specimens, we feel disposed not to diagnose a new species, but to ally our form with that of Egypt and San Giovanni Ilarione.

Euspatangus rostratus, d'Archiac, is found in the beds with Orbitoides, and the remarks already made will apply to it; it is the only species which passes from the Nummulitic to the Oligocene in Kachh.

Remarks on the Species of Echinoidea from the Miocene Series of Kachh.

The *Cidaris* which is found in the Miocene series of Kachh is that *Cidaris Halaensis* which was described by MM. d'Archiac and Haime from the Nummulitic strata of the mythical Chaine de Hala. It is a well-marked species, and adds to the number of the Tertiary Cidaridæ, with not very depressed tests and moderately broad and not narrow interporiferous areas, which are decorated with two or three minute tubercles, one being larger than the others, on each interporiferous plate. The resemblance to European Tertiary species is slight; and the species has only a generic relationship with the recent *Cidaris metularia*, Blainv. The small secondary tubercles on the slope of the coronal plates and beyond the larger ones of the scrobicular circle are pointed and round in outline and have minute mamelons. The tubercle close to the poriferous zone in the ambulacrum is about the size of the third grade of coronal tubercles, and is therefore small for a secondary. A narrow sunken line, without ornamentation, is over the vertical sutures in the median interambulacra. Moreover there are a few milaries, or one or two vertical series of three, between some of the larger tubercles of the scrobicular circle, which are along the transverse suture between the vertical series of coronal plates. This apparently unimportant ornamentation links the species to one which will be noticed from the Miocene of Kattywar.

There is nothing remarkable about the *Goniocidaris* except that it differs from the recent species, yet has some points which link these last together. The spines are moderately large, but it is interesting to know that they are smaller than those belonging to a later deposit in the Persian Gulf.

The *Cœlopleurus* is also a form believed to be Nummulitic by d'Archiac and Haime, and is their species *C. Forbesi*. The specimen is less weathered than the type of the species in the collection of the Geological Society; but when it is compared with one from the Miocene of Kattywar the results of the weathering and sand-scratching can be appreciated. A moderately sized tubercle is on each of the generative plates, yet it is hardly visible in the Kachh specimen, and not at all in the type.

Cœlopleurus Forbesi, d'Archiac, is essentially a Miocene form, and is found in great abundance in the Gāj series of Sind.

The genus *Cœlopleurus* has a considerable range, and is found in the Nari deposits of Sind, which are Oligocene in age. It occurs also in the Miocene of Sind and Kattywar; but the Nari species is not *Cœlopleurus Forbesi*. *Cœlopleurus equis*, Agass., and *C. Pratti*, d'Archiac, are the Oligocene species, and *C. Forbesi* the Miocene form. Alex. Agassiz has given beautiful representations of the Oriental *Cœlopleurus Maillardi* in his Report on the 'Challenger' Echini, plate vi; but our examination shows that the Miocene form differs considerably in the shape of the apical plates and in the details of the ambulacra.

We have considered the generic position and structural details of the Temnopleuridæ which are such characteristic fossils of the Miocene series of Kachh in dealing with the species. The distinction of the closely allied species of *Dictyopleurus* of the Nummulitic series of Sind from the beautiful Temnopleurids of Kachh is explained; and it is noticed that, notwithstanding the vigorous onslaught of d'Archiac and Haime on Edward Forbes's genus *Temnechinus*, their own species of *Temnopleurus* must come under it. Exception may be taken for *Temnopleurus tuberculosus*, d'Archiac, as will be explained in noticing the Kattywar Echini, but we do not retain the genus *Opechinus*, Desor. The anatomy of the test of *Temnopleurus toreumaticus* and of the allied forms of *Salmacis* has been examined by one of us; and the nature of a true species of *Temnopleurus* has been established. The special structures are not found in the forms called *Temnopleurus Rousseaui*, *T. costatus*, and *T. Hookeri* by d'Archiac; these are varieties of one species, which we refer to *T. Rousseaui*, but all are *Temnechini*. The fact that in some full-grown specimens of *Temnechinus Rousseaui* there are no fossettes in the actinal half and very few elsewhere, is very suggestive. D'Archiac and Haime were in fault in accrediting their species with a Nummulitic horizon. All have been found by us in the Miocene of Kachh and Kattywar, and only one specimen came from the Khirthar of Sind, and its appearance is against its being really found in place.

Alex. Agassiz notices these species of d'Archiac and Haime in his 'Revision of the Echini,' and came to the same conclusion which we adopt from the consideration of the data before him in 1872–1874. He writes (p. 289):—"D'Archiac and Haime have figured from the Nummulitic formation of India a number of species which are usually referred either to *Temnopleurus* or to *Opechinus*, which belong to this same genus *Temnechinus*." We agree with this opinion after an examination of a great many specimens; and of course the only error in the statement is due to the mistake of d'Archiac and Haime in placing the forms in the Nummulitic series.

A great number of small *Clypeasters* with hollow actinal surfaces, and recalling *Clypeaster scutiformis* in the general shape, but differing from that modern type, are found in the Miocene of Kachh. Sowerby named and delineated them in Grant's work on Kachh, and they appear to be very common. Larger forms also exist; but still none of those are found which are so remarkable in their shape and dimensions and which characterize more westerly Tertiaries.

Clypeaster Waageni and *C. Goirensis* are rather closely allied; both have thin depressed tests more or less pentagonal in outline, and the relation of the length to the breadth is close, being in the former 1 to 0·82, and latter 1 to 0·88.

Clypeaster Goirensis is broadest in front, has relatively smaller petals, but they are decidedly broader than those of *C. Waageni*, and this is especially noticed in the postero-lateral petals. The very open nature of the distal extremity of the petals is as decided as in the Oligocene species of Kachh; and there is the same disposition on the part of the last pores of the poriferous zones to open still wider.

The rarity of fossil forms of *Echinodiscus* renders the species from Kachh interesting. It is a true *Echinodiscus*, departing in no way from the generic type; the internal pillars are in existence, and the ambulacral grooves have a raised ridge in their long axis close to the peristome, which is penetrated at the free nodular end by two pores. It is closely allied to an Egyptian Miocene form which Fuchs has placed under *Amphiope*, a genus no longer recognized.

The Echinolampads from the Miocene of Kachh are numerous in individuals, and there are four species—two of them being new; and the others are *Echinolampas sphæroidalis*, d'Archiac, and *E. Jacquemonti*, d'Archiac, which were said to come from the Nummulitic series. They do not, however; but characterize the Miocene series. The other forms recall the recent species, but differ nevertheless specifically from any living forms.

The Spatangidæ are important in the Kachh Miocene fauna. *Euspatangus patellaris*, d'Archiac, is found in great beauty, the ornamentation being remarkably preserved. It is not a Nummulitic form, and closely resembles *Maretia*, but it has a fasciole. The anterior odd ambulacrum has exceedingly minute pores placed in pairs at the bottom of small spaces surrounded by a beautiful granulation; and the actinal plastron is very broad.

The curious genus *Moira* has a well-marked species in the Miocene of Sind; and a careful examination of the morphology shows that it is a very synthetic type, having some of the characters of both of the living species,—*Moira stygia* from the Red Sea, and *M. atropos* from the Caribbean Sea.

The species drawn by us on Plate VII, figs. 9–12, is certainly not a *Brissopsis*. It is a Spatangoid with sunken open ambulacra, a peripetalous fasciole which passes between large sunken tubercles situated in the anterior and lateral, but not in the posterior, interradia, and a well-marked subanal fasciole. The test is tumid above and below. Neither can this species come within the genus *Brissopatagus*, which has no subanal fasciole, although its peripetalous fasciole lies between large sunken tubercles.

De Loriol, with his usual perspicacity and able discrimination, classified an anomalous form from the neighbourhood of Thebes as *Euspatangus**. Now his *Euspatangus Cotteaui* has the paired ambulacra lodged in deepish grooves. The petals, however, are those of the genus; and the peripetalous fasciole does not enter the area between the ambulacra; moreover the form is depressed.

We cannot admit the form now under consideration within *Euspatangus*, and it must be included in a genus of Spatangoids which, with great affinities to *Euspatangus*, *Maretia*, and *Brissopatagus*, is still as distinct as they are.

This new genus *Troschelia* contains Spatangoids more or less cordiform, tall and tumid. The anterior ambulacrum is in a groove which notches the ambitus; the other ambulacra are in deep grooves, the antero-lateral very divergent. Large tubercles in sunken scrobicules on the anterior and lateral interradia only. Peripetalous fasciole separating tubercles and entering the area between the lateral petals. Subanal fasciole large and well developed.

The *Breynia* is a fine form; and the condition of preservation of the specimen allows the internal fasciole to be seen perfectly. It passes much more in front than was drawn by MM. d'Archiac and Haime. Moreover it is clear that the inner pores of the anterior poriferous zone of the antero-lateral ambulacra are distinct but small; they do not abort as is the case in the recent species. The number of large tubercles in the areas constitutes a remarkable feature. The species is not found in the Nummulitic as stated by MM. d'Archiac and Haime.

The only *Schizaster* from Kachh which was sent by the Geological Survey is remarkable for its great beauty of ornamentation, the outward turn of the narrow pointed anterior petals, the rather depressed shape, the swollen condition anteriorly, and the narrow pointed hinder end. It came from an unknown locality; and this is to be regretted, for although the form is clearly of Miocene age in Kattywar, it is found in the Nari series of Sind, part of which at least is Oligocene.

The Miocene fauna of Echinoidea is especially characterized by the genera *Cœlopleurus*, *Temnechinus*, *Clypeaster*, *Echinodiscus*, *Echinolampas*, *Breynia*, and *Moira*. There are no species, however, which so closely approach recent forms as to be difficult of discrimination. No less than six species which have hitherto been termed Nummulitic, and which were described by d'Archiac and Haime, now evidently belong to the Miocene of India and not to a lower horizon.

This Miocene horizon is not a high one, and is the equivalent of the Gáj deposits of Sind. It is not covered by Pliocene marine deposits; but there are Pliocene deposits with an Echinoidean fauna which constitute the Makrán series of Ras Malán in Baluchistan and of Bushir &c. in the Persian Gulf. The Echinoidea of these Tertiary deposits differ.

The alliance of the Miocene fauna of Kachh with that of Europe is only generic, but the facies is remarkably persistent in the east and west.

* *Op. cit.* p. 140 (84).

VIII. *Description of the Fossil Echinoidea from the Tertiaries of Kattywar.* (MIOCENE.)

Order **ECHINOIDEA ENDOCYCLICA.**

Family CIDARIDÆ.

Genus CIDARIS, *Klein*, 1734.

1. CIDARIS DEPRESSA, *Duncan & Sladen.* Plate XIII, Figs. 1–3.

The test is very depressed and broad, the peristome is small, and the ambulacra sinuous and broad.

The poriferous zone is much broader than the interporiferous area; the pores are separated by a raised ridge, but the pairs have only the sutural line between them. A vertical row of small secondaries is on each side in the interporiferous area, just beyond the poriferous zone. A minute tubercle is also found close to each one of the vertical series. There is thus a large and small tubercle to each plate. The interradial plates are broader than long; the tubercle occupies much of the surface, and is nearer the poriferous edge than the median line; the boss is low, with a depressed small-necked mamelon. There is no crenulation, but the mamelon is perforate. There is a row of well separated small secondaries around the scrobicular area, and two rows of smaller ones nearer the median line. Actinally and abactinally there is only the solitary row, which is sometimes incomplete; and a row of very small tubercles is between those of the scrobicular circle and the poriferous zone.

Locality. Kattywar Miocene. Three miles east by north of Gága, and south-east of Gurgat. Survey-number $\frac{H\,1}{26}$.

Illustrations of the Species in Plate XIII.

Fig. 1. The test: natural size.
2. Two ambulacral plates: magnified.
3. Diagram of a section of an ambulacral plate.

2. CIDARIS GRANULATA, *Duncan & Sladen.* Plate XIII, Figs. 4–6.

The test is broad and depressed. The ambulacra, moderately wavy, are broad, especially in the interporiferous area; the pores are separated by a raised ridge, and there is a raised narrow linear ridge between the pairs. A small tubercle is close to the inner pore, and towards the median line there are two others, the inner being the smallest. There are thus six vertical rows of tubercles in the interporiferous area. There are ten pairs of pores in relation to one side of an interradial coronal plate. The larger interradial plates are broader than long, well defined by the sutures; and the large and broader than long boss occupies the greater part of the plate, and is placed rather on the outer half, so that there is more space towards the median line beyond it than near the poriferous zone. The boss slopes upwards with a slightly re-entering outline from the base to the broad top. This is grooved around the neck of the rather small depressed mamelon, and is faintly crenulated on one side in most instances. The mamelon is perforated. At the edge of the scrobicular circle are some radiating depressions, shallow and broad, and they end in a radial row of about three granules, which are between the principal secondaries of the circle. These secondaries are small, rather wide apart, largest on the equatorial parts of the plate, and smallest abactinally and actinally; they have a mamelon, which is elongate, its long axis being towards the boss.

Actinally and abactinally each plate has a single row of these secondaries, separated by the intervening rows of granules.

Towards the median line there is a row of smaller tubercles alternating with the larger, and still further there are two other rows of smaller and distant tubercles, the last being almost miliary in size. Between the scrobicular circle of tubercles and the poriferous zone there is one row of smaller secondaries and some granules.

Locality. Kattywar Miocene. Three miles east by north of Gága, and south-east of Gurgat. Survey-number $\frac{\text{H 1}}{25}$.

Illustrations of the Species in Plate XIII.

Fig. 4. The test: natural size.
5. The ambulacrum, in part: magnified.
6. A coronal interradial plate: magnified.

Family ARBACIADÆ.

Genus CŒLOPLEURUS, *Agassiz*, 1840.

1. Cœlopleurus Forbesi, *d'Archiac & Haime.*

This species has been already noticed in the description of the Miocene Echinoidea of Kachh, page 53.

Family GLYPHOSTOMATA.

A very remarkable form occurs in the Miocene of Kattywar; although its shape and structural details are exceedingly suggestive of several well-known genera, it cannot enter any one of them. At first sight the resemblance of the Kattywar specimen to the actinal surface of *Micropsis Fraasii*, de Loriol ('Échinides contenus dans les couches Nummulitiques de l'Égypte,' plate 1, fig. 17), is extraordinary; but in the later form from Kattywar the tubercles are neither crenulated nor perforate, and the pores are decidedly in triplets. It reminds the observer of the genus *Polycyphus*; but the multiplication of the pores around the peristome seen in this genus does not exist in the new form, whose peristomial lips are not very narrow. There is a resemblance to species of *Stomechinus*, especially in some points to *Stomechinus Greslyi* and *S. Miche-*

lini (de Loriol, Pal. Suisse: 'Descr. des Oursins fossiles de la Suisse'). But here, again, the sharp projecting ambulacral lip is not seen in the Miocene form.

There is a furrowing of the horizontal suture-edges of the interradial plates, which recalls the Temnopleuridæ, but no pits or deep furrows are to be seen; and the likeness is increased by the nature of the triplets, which resemble those of *Salmacis*. We include the form in a new genus.

Subfamily TRIPLECHINIDÆ, A. Agassiz.

Genus GRAMMECHINUS *, gen. nov.

The test is thin, rather depressed, swollen at the ambitus, flat or incurved actinally, low and conical abactinally. Marginal outline slightly pentagonal or nearly circular. Ambulacra with pairs of pores in regular triplets from apex to peristome; plates with from one to three tubercles on them. Interambulacral plates broad and low, carrying from one to eight tubercles, the number diminishing towards the apex. Tubercles of both series neither perforate nor crenulate, small; secondaries in lines above and below the primaries, forming ridges, with the depressed horizontal sutural line between the two series. Vertical ridges of small tubercles, more or less linear in shape, may be in relation with the largest tubercles. Actinostome moderately large, rather pentagonal; cuts moderately developed; ends of ambulacra moderately wide. (Apical system wanting.)

1. GRAMMECHINUS REGULARIS, *Duncan & Sladen.* Plate XIII, Figs. 7, 8.

The test is circular or slightly pentagonal in marginal outline, tumid at the ambitus, conical and rather depressed abactinally, slightly incurved actinally around the rather large peristome, which is rather pentagonal in outline. The ambulacra are broad, and at the ambitus are one half the breadth of the interradium; more abactinally the ambulacrum is two thirds the width of the interambulacra, and nearer the peristome the relative breadth becomes rapidly less. The ambulacral plates are tall in relation to their breadth near the peristome, and carry at first one and then, more abactinally, two tubercles. At the point of greatest breadth the plates are broader in relation to height and carry three tubercles. Each plate has three pairs of pores, forming a curved line. The pores are large and separated by a projection; and the pairs, also well separated, have a granular, or plainly linear, raised structure between them. Immediately actinally to the second pair of the triplets is a small tubercle, and there is a smaller one on a line with and externally to the first pair. The tubercles of the ambulacra are broad at their base and have a distinct mamelon, which is neither perforate nor crenulate. The tubercle nearest the pores is the largest, and is crossed by the sutural lines of the poriferous plates. The remaining tubercles are larger than those immediately beyond the line of pores, and all have a mamelon.

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* γραμμή, a line.

A small tuberculation is above and below the larger tubercles on the plates; it is distinct, unequal, and in lines parallel with the abactinal and actinal sutures, which are grooved, as it were, by the lines of raised ornamentation becoming abrupt over them. There is often a very small tubercle between the larger innermost two on the plate; and near the actinal surface, where there are only two tubercles, a line of small tubercles is parallel with the median suture. This tuberculation, surrounding the larger tubercles on three sides, is unequal.

The interradial plates are very broad in relation to their vertical measurement, and are all characterized by having a row of tubercles along the central line of the breadth, increasing in number from three near the cuts to seven or eight at the ambitus. The tubercles have circular bases standing above the level of the plate, supporting smaller conical bosses, and well-developed, nearly hemispherical mamelons, which are imperforate. There is no crenulation. The fourth tubercle from the ambulacral side is the largest, and the three nearest the median line are the furthest apart.

The actinal and abactinal sutures are grooved, and there is a raised minute ornamentation on the plate immediately above and below the grooving. This ornamentation is of one, two, or three rows, in different parts, of small tubercles, some circular and others elongate vertically in outline. The tubercles, of different sizes as well as of shapes, project; and some in relation to the largest tubercle, and those on either side of it, assume quite a vertical linear form, most readily seen when the light crosses the vertical line of the plate at right angles. Actinally, and where the number of the tubercles is less, there is often some deviation from the horizontal line so well kept at the ambitus: moreover there are small tubercles along the line of the median suture, which presents a feeble furrow.

It is evident that the furrowing of all the sutures is produced by the ornamentation, which is highest close to them, and slopes inwards towards the centre of the plate.

The peristomial cuts are well developed, have a raised border, and enter well into the second interradial plate.

Measurement from peristome to extreme bulge 17 millim.; breadth of the peristome 14 millim.; extreme breadth of test 48 millim.; probable height 40 millim.

Locality. Kattywar Miocene. Half a mile east of Lowaráli, Oka Mandol. Survey-number $\frac{\text{H 1}}{13}$.

Illustrations of the Species in Plate XIII.

Fig. 7. The imbedded test: natural size.
8. Ambulacral and interradial plates: magnified.

Subfamily TEMNOPLEURIDÆ, Desor.

This subfamily is largely represented in species and individuals in the Miocene of Kattywar. The genus is, however, *Temnechinus*, Forbes, = *Temnopleurus*, d'Archiac; and in only two specimens have we found crenulation, and then in one or two tubercles only. These we have figured on Plate XIII, Figs. 15 & 16; and it will be noticed that it is the largest tubercles which are crenulated. We do not therefore feel disposed to depart from our determination that these forms are true *Temnechini*.

It is satisfactory to find a resting-place in classification as well as in geological distribution for the so-called Nummulitic Temnopleurids of MM. d'Archiac and Haime. Without exception, all the species which we can recognize as good for anything, viz. *Temnechinus Rousseaui*, *T. costatus*, and *T. tuberculosus* of d'Archiac and Haime, come from Miocene strata.

Genus TEMNECHINUS, *Forbes*, 1852.

1. TEMNECHINUS COSTATUS, *d'Archiac*, sp. Plate XIII, Figs. 9, 10.

This species, with shorter costulate processes in the ambulacra than is the case in *Temnechinus affinis*, nobis, has taller ornamented interambulacral plates, which do not cross their area as narrow bands, but break up along the median line into short processes, which join the other plate obliquely, and have fossettes above and below them. Hence there is a kind of close confused series of fossettes and processes in the median line. The true shape of the species is tall and tumid, diminishing apically and towards the ambitus.

Locality. Kattywar Miocene. Three miles east by north of Gága. Survey-number $\frac{H\ 1}{26}$.

Illustrations of the Species in Plate XIII.

Fig. 9. The test: natural size.
10. A portion: magnified.

The type was described by d'Archiac and Haime (*op. cit.* p. 204, plate xiii, figs. 9, *a*, *b*), and they lay great stress upon the two vertical series of large tubercles in both series being on a subcostiform projection. This is not invariable. Again, they notice with greater truth the small fossettes of the interambulacral median line, which are represented in our Figure 10, Plate XIII.

2. TEMNECHINUS ROUSSEAUI, *d'Archiac*, sp. Plate XIII, Figs. 13, 14, 15.

Several specimens of this species are in the Kattywar collection, but one is almost a variety. It is tall, and the fossettes are very large and deep; but the interambulacral plates are low from above downwards in their ornamentation, and the ambulacral ornamentation resembles that of our figure, Plate XIII, Fig. 10, but with larger fossettes.

Locality. Kattywar Miocene. Three miles east by north of Gága and south-east of Gurgat. Survey-number $\frac{H\ 1}{26}$.

Illustration of the Species in Plate XIII.

Fig. 13. Diagram of a section: natural size.

From the same locality are some specimens of more depressed types of this species, and their breadth is unusual. It appears to be produced by an extra breadth of the interambulacral plates at the ambitus, and there is an extra small tubercle to the ornamental part of the plate, and usually a corresponding vertical ridge; but higher up in the test the plates resemble those of the normal type.

It is evident that some, but not all, of the tubercles are crenulated.

Illustrations of the Species in Plate XIII.

Fig. 14. The test: natural size.
15. A plate near the ambitus: magnified.

We restrict this form within the limits of *Temnechinus*, and do not see the necessity of admitting the genus *Opechinus*, Desor.

3. TEMNECHINUS TUBERCULOSUS, *d'Archiac & Haime*, sp. Plate XIII, Figs. 16, 17.

This species was well described in 'Les Animaux fossiles de l'Inde,' p. 206, and figured; but the specimen we have is not much crushed, and it is clear that the shape of the test is turban-shaped, swollen at the margin and above it, and then tapering off to a rather flat top. It is not pentagonal.

The specific distinction is the presence of vertical processes which divide the ambulacral fossettes into two. The interambulacral plates resemble those of the large plates of the largest *Temnechinus Rousseaui*, d'Archiac, sp. (See our Plate XIII, Fig. 15.)

Another distinction is the tumid body of the generative plates and their angular extremity, which is perforated by a large pore. It is clear that some, but not all, of the tubercles are excessively finely crenulate, as is the case in the exceptional plate of the *Temnechinus*, fig. 15.

Height 12·5 millim., breadth 19·5 millim.

Locality. Kattywar Miocene. Three miles east by north of Gága and south-east of Gurgat. Survey-number $\frac{H\,1}{26}$.

Illustrations of the Species in Plate XIII.

Fig. 16. Part of an interambulacrum and ambulacrum: magnified.
17. Diagrammatic section: natural size.

A new species must be added to this list from Kattywar; and as it allies *Temnechinus costatus*, d'Archiac, to *Temnechinus tuberculosus*, d'Archiac, we have called it *Temnechinus affinis*. It has slender oblique ridges, with large open fossettes in the ambulacra, and the slender oblique costulation of the interradial plates is united by vertical processes. In *T. costatus* the ambulacral ridges are stouter, and they are stouter still in *T. tuberculosus*: in the first the fossettes are large and open, and in the latter they are small and crossed by a vertical process.

In *T. costatus* the interradia closely resemble those of *T. tuberculosus.* The true shape of *T. costatus* is high, that of *T. tuberculosus* is broader and more depressed, and that of *T. affinis*, nobis, is still more depressed.

4. TEMNECHINUS AFFINIS, *Duncan & Sladen.* Plate XIII, Figs. 11, 12.

The test is turban-shaped, broader than high, rather flat actinally, tumid at the ambitus, and less so in the more conical upper part, and depressed abactinally. Test symmetrical; peristome very small, and cuts small. Apical system small. At the ambitus the width of an ambulacrum is very nearly equal to that of an interradium. Poriferous zone broad, slightly sunken: pairs of pores in triplets, but in simple succession; each pair is placed on the lower slope of a narrow costulate process; the upper pair of each triplet has its costulate process continuous with the ambulacral plate, on which is a small tubercle, and the other two are in relation with the small primary tubercle, which is on the two lower plates in the interporiferous area. There is a vertical row of small primary tubercles on each side of the interporiferous area near the poriferous zone. Each of these small primaries is connected with the smaller tubercle above the primary in the lower plate by a narrow process. Rib-like processes cross the interporiferous space from the small primaries and smaller tubercles of one vertical series to the other; their direction is oblique and in zigzag, and they are narrow from above downwards, granular or minutely tuberculated, and usually the largest of their tubercles is near the primary whence they originate. This raised ribbing produces broad and rather low (that is, vertically) fossettes, and their shape is that of a broad straight comma. There is a vertical row of these fossettes on either side of the median line of the ambulacrum. In the interambulacra there are two vertical rows of small primaries, which are slightly larger than those of the ambulacra; they are nearer the poriferous zone than the median line, are wide apart at the ambulacrum, and the raised surface on which each tubercle of a series rests is connected with that of the tubercle above and below by a constricted process.

Long and rather narrow zigzag ribs pass from near the primaries across the median line to those of the adjoining plates, and smaller costæ join on to those of the poriferous zone on the other side of the primary tubercle. Small vertical costulate processes pass from the actinal edge of one zigzag to the abactinal edge of the one below, and thus interfere with the continuity of the very long transverse fossettes. Usually there are two of these processes in each fossette between the two rows of primaries, and there is one on the other side of the primary and between it and the poriferous zone in a well-marked fossette there. So that, including the large vertical processes between the tubercles of each vertical series, there are eight vertical raised lines, more or less costulate and ornamented, in each interradium. Nearer the abactinal surface the breadth of the fossettes diminishes, and one of the smaller vertical series is not seen; and quite close to the apex there is only the main vertical series of each side, which connects the primaries above with the one placed actinally to it. The result of the presence of these vertical processes is to subdivide the fossettes into several others. On either side, and actinally to the primary and its process, is a well-marked small fossette, usually more or less oval or elliptical in outline and taller than broad. Nearer the median line is another fossette of nearly the same size and shape; and still nearer the angle of the diverging costæ is a more or less concave-shaped one. Even this may be subdivided. On the poriferous side of the primary, and between the extremity of the second and third pairs and the vertical costulate process which exists between the ambulacrum and the vertical line of the primaries, is a fossette; it is broad towards the primary and narrow towards the pores. Hence there are two fossettes between the primary and the poriferous zone, and three or four fossettes in a row between the transverse oblique or zigzag ribs which stretch across the interambulacral areas. Abactinally the number of fossettes diminishes and actinally also.

The minor ornamentation of the plates on either side of the primaries and of the ribs is very elegant, and consists of small mammillated tubercles and distinct miliaries. Usually there is a small tubercle second to the primary in size on either side of it, and beyond that which is in relation to the arch of miliaries abactinal to the primary. Tubercles may be on either side of the root of the vertical processes or upon it. The tubercles are imperforate and non-crenulate.

Locality. Kattywar Miocene series. Three miles east by north of Gága and south-east of Gnrgat. Survey-number $\frac{H\,1}{26}$.

Illustrations of the Species in Plate XIII.

Fig. 11. The test, side view: natural size.
12. Part of an ambulacrum and interradium: magnified.

Order **ECHINOIDEA EXOCYCLICA.**

Family SPATANGIDÆ.

Subfamily SPATANGINÆ.

Genus EUSPATANGUS, *Agassiz*, 1847.

Eupatagus, *Agassiz*, 1847.

1. EUSPATANGUS PATELLARIS, *d'Archiac.*

This species is found in Kattywar; and our specimens show the fasciole very distinctly, externally to the posterior ambulacra. It crosses the posterior interradium considerably in the rear of the line of the distal end of the ambulacra.

The anterior poriferous zone of the antero-lateral ambulacra has its pores visible.

but very small near the apical system. The pores of the odd ambulacrum are also visible.

Locality. Kattywar Miocene. Three miles east by north of Gága, and south-east of Gurgat. Survey-number $\frac{\text{H 1}}{28}$.

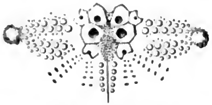
Genus SCHIZASTER, *Agassiz*, 1836.

1. **Schizaster Granti,** *nobis.*

This is the commonest fossil in the collection from Kattywar, and some of the specimens are larger than the type from Kachh (page 70). The specific characters are, however, well maintained; and it is noticed that even in the largest specimens the keel on the posterior interradium is low, and that it slopes backwards and downwards to the point which overhangs the periproct. The anterior groove is broad and deep abactinally, and is shallower and less evident in front of the curved fasciole.

The anterior ambulacral pores are separated by a nodule, and they are on the flanks of the groove. The pairs of pores have a more or less definite swelling like an indefinite costa between them; and the floor and sides of the groove are very granular, the larger tubercles being near the top of the keel on either side.

The antero-lateral ambulacra flare outwards, are in deepish grooves, and become more or less pointed distally. The obliquity of the pores is not so evident as in the Kachh species, but the granulation of the costæ is evident.



The apical system, magnified.

The apical system has four generative plates and four pores; the anterior plates are rather long in the antero-posterior direction, and include the small anterior ocular plate in their angle. The posterior lateral plates are large; their pores are larger than the others and wider apart. The ocular plates are in the angles of the plates and are well developed; the posterior pair are separated by the madreporic extension.

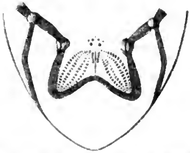
The whole apical system is small; the anterior genital pores are on the anterior keels, and the others on the narrow keel of the lateral ambulacra, which is sparely tuberculate.

The posterior ambulacra are stout, sharp at the end, shallow, and there are about 17–19 pairs of pores.

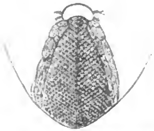
The peripetalous fasciole resembles that of the type, and is very distinct; it is narrow where it passes over the keel, behind the posterior ambulacra. The subanal branch passes rather close beneath the oval elliptical anus, which is considerably sunken in consequence of the projection of the keel backwards and of the similar direction of the termination of the actinal plastron. The anus is visible from the actinal surface.

Finally, the projecting actinal plastron, bounded by the peculiarly granulated shagreened posterior ambulacra, is as definite as in the type. The posterior lip has a very decided fold in well-preserved specimens.

Locality. Kattywar Miocene. Three miles east by north of Gága, and south-east of Gurgat. Survey-number $\frac{\text{II } 1}{21}$.



The fascioles on the posterior part of the test.



The ornamentation of the plastron.

Genus BRISSOPSIS, *Agassiz*, 1840.

1. Brissopsis, sp.?

A much crushed specimen of an Echinoderm is in the collection from Kattywar; and its generic determination is so full of difficulties that we place it with some doubt under the genus *Brissopsis*: it is not *Brissopsis scutiformis*, d'Archiac & Haime[*], which is a *Metalia* of the Nummulitic of Sind.

In the specimen under consideration the posterior petals are close, especially near the apex, and their curve is concave forwards and outwards; they are petaloid, very widely displayed and shallow, closed at the end, with exceedingly narrow interporiferous and broad poriferous zones, the pores of each pair being very far apart.

The antero-lateral ambulacra are wide apart, but not nearly transverse, are shorter than the posterior, and are in deep grooves, the pores being on the flanks. The interporiferous area is rather broader than that of the posterior ambulacra, and yet not so wide as the space between the pores of a pair. All the pairs are separated by well-developed costæ. The odd ambulacrum is in a deep groove, and the pores are small and wide apart; the groove notches the margin. There are traces of a fasciole surrounding the petals and crossing the broad keel behind. The test is longer than broad, highest behind at the truncation, on which is the periproct.

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[*] *Op. cit.* plate xv, figs. 5 *a* and 5 *b*.

Actinally the plastron is tumid and projects; but all other details are wanting.

It is evident, however, that the pores near the apex of the posterior poriferous zone of the posterior ambulacra are atrophied from about the 18th, counting from the outer ends, to the 26th; moreover the pores of this zone are smaller than those of its fellow before decided atrophy commences.

Locality. Two miles north of Visáwára, above Porbandar. Survey-number $\frac{H\ 1}{32}$.

There are, moreover, some fractured specimens of a *Clypeaster* in the collection, and the species may be *C. depressus*, Sowerby.

A very much worn and crushed specimen resembles somewhat a *Breynia*.

IX. *Remarks on the Species of Fossil Echinoidea from Kattywar.* (MIOCENE.)

There is nothing very striking about the two species of *Cidaris*, but they are distinct from those of Kachh. *Cidaris granulata* is interesting on account of its elaborate minute granulation between the secondaries around the scrobicule, and for the partial crenulation. None of the subgenera of *Cidaris* are represented in the collection.

Cœlopleurus Forbesi is a well-marked form, and is the Miocene *Cœlopleurus* par excellence of the Tertiaries of Western India. It is found in Kachh, Kattywar, and largely in the Gáj series of Sind. A careful examination of the species, which was originally determined by d'Archiac and Haime from one very indifferent specimen, will be given in the description of the Fossil Echinoidea of Western Sind, Gáj series. There are three well-marked species of the genus in the Tertiaries of India—*Cœlopleurus equis*, Agass., from the Oligocene, *C. Pratti*, d'Archiac, from the Oligocene, and *C. Forbesi*, d'Archiac, from the Miocene.

The new genus *Grammechinus* is found also in the Gáj series of Western Sind, but not in Kachh. It is an interesting species, for the grooved horizontal sutures, the number of tubercles imperforate and non-crenulate, the triple arrangement of the pores, and the defined cuts seem to recall several genera.

The beautiful Temnopleurids of Kattywar are a strong feature in its fauna, and there are four species of *Temnechinus*=*Temnopleurus*, d'Archiac. Three of d'Archiac and Haime's species are found in Kattywar, viz. *T. costatus*, *T. tuberculosus*, and *T. Rousseaui*. The new species *T. affinis*, nobis, is an exquisite form, and its ornamentation is very elaborate. This area appears to be the metropolis of the species, but none of the *Arachniopleuri* or *Dictyopleuri* have been found there. It is remarkable that a true *Temnopleurus* or *Salmacis* should not be found, especially as species of these genera are common off the coast.

The absence of *Echinolampinæ* from the collection is remarkable. *Euspatangus patellaris*, d'Archiac, is found in Kattywar as well as in the Kachh Miocene.

The commonest fossil in Kattywar is *Schizaster Granti*, nobis, which had no satisfactory geological horizon given to it in Kachh. *Schizaster Granti*, nobis, is a beautiful form, with sharp-pointed antero-lateral petals flaring outwards and a low keel on the posterior interradium; it has a transverse concavity posteriorly, so that the test above the periproct projects backwards and the hinder part of the plastron also. The periproct is visible from the actinal view, although it is high up posteriorly. The granular ornamentation of the postero-lateral ambulacra on either side of the actinal plastron is very characteristic. The species is very distinct, and yet it has been mistaken for *Schizaster Baluchistanensis*. It is the common *Schizaster* of the Miocene of Western India.

APPENDIX.

The following species was accidentally omitted from the Nummulitic fauna of Kachh. It is interesting on account of its alliance with a Sindian Nummulitic form.

Genus SISMONDIA, *Desor*, 1857.

1. SISMONDIA POLYMORPHA, var. SUFFLATA, *Duncan & Sladen*.

This form constitutes a well-marked variety of a species we are about to describe from the Khirthar series of strata in Sind. It is characterized by a generally much smaller habit, by a comparatively thicker margin, and especially by the low, but decided, convexity of the abactinal surface. The same great variability in the marginal contour is noticed, although the more elongate and less angular forms appear to prevail. The characteristic tumidity of the postero-lateral petals is also present. The petals terminate at a greater distance from the margin than in the type form, and are very short for the genus.

The length of one of the largest specimens is 7·5 millim., and the breadth 6·5 millim.

Locality. From the Nummulitic series of strata of Kachh. Three or four miles north-north-east of Pipúr. Survey-number C 039.

PLATE I.

(*Nummulitic Series.*)

Figure 1. ECHINOLAMPAS ALTA, Duncan and Sladen (page 19). Side view, natural size.
2. Actinal view, natural size.
3. Apical system, magnified twice.
4. Peristome, magnified.
5. End of antero-lateral ambulacrum, magnified.
6. Ornamentation of an ambulacrum, magnified.
7. Variety (page 22). Actinal surface, natural size.
8. ECHINOLAMPAS FEDDENI, Duncan and Sladen (page 23). Side view, natural size.
9. Abactinal view, natural size.
10. Ambulacrum, part of, magnified.
11. A postero-lateral ambulacrum, magnified.

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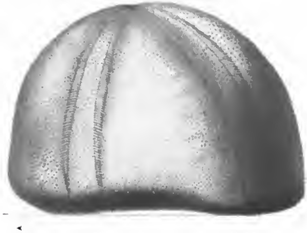

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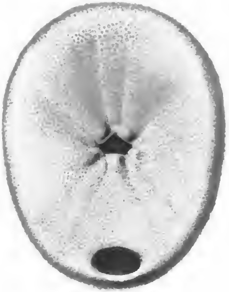

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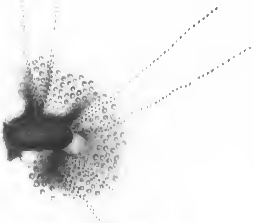

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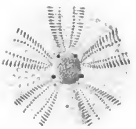

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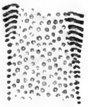

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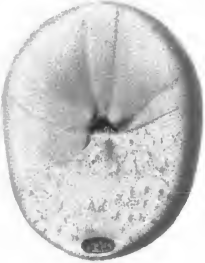

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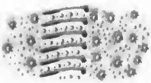

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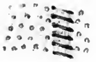

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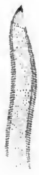

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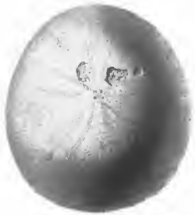

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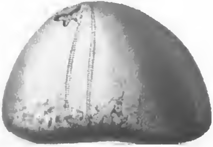

Duncan & Sladen del. A. Gawan lith.

Mintern Bros.

Fossil Echinoidea from Kach.

PLATE II.

(Nummulitic Series.)

Figure 1. ECHINOLAMPAS KACHENSIS, Duncan and Sladen (page 25). The test seen from the side, natural size.

2. Abactinal view, natural size.
3. Actinal view, natural size.
4. The end of an ambulacrum, magnified.
5. ECHINOLAMPAS, species (page 50). Abactinal view, natural size. (*Oligocene Series.*)
6. ECHINOLAMPAS HAIMEI, Duncan and Sladen (page 26). Abactinal view, natural size.
7. Actinal view, natural size.
8. Part of phyllode, magnified.
9. ECHINOLAMPAS DAMESI, Duncan and Sladen (page 27). Abactinal view, natural size.
10. Ornamentation, magnified.

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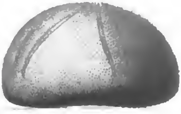

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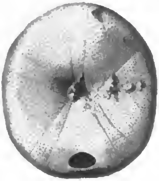

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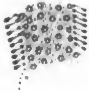

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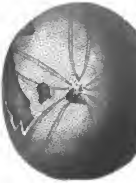

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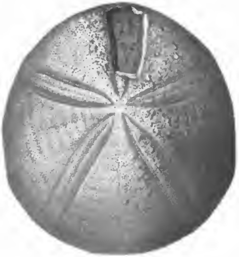

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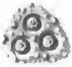

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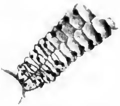

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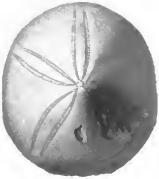

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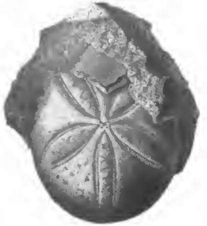

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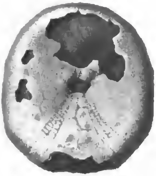

Duncan & Sladen, del. A. Gawan lith. Mintern Bros. imp.

Fossil Echinoidea from Kach.
Nummulitic Series

PLATE III.

(Nummulitic Series.)

Figure 1. **Echinolampas Damesi**, Duncan and Sladen (page 27). Actinal surface.
2. **Echinolampas Feddeni**, Duncan and Sladen (page 23). Actinal view.
3. **Echinolampas insignis**, Duncan and Sladen (page 29). Abactinal view.
4. A side view.
5. Actinal view.
6. Part of an ambulacrum, magnified.
7. **Echinolampas**, sp. (page 32).

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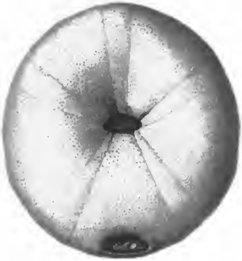

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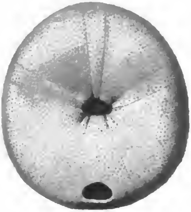

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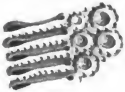

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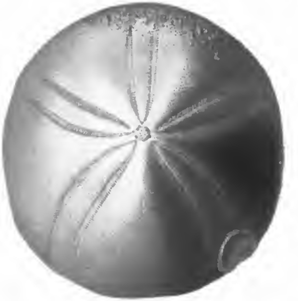

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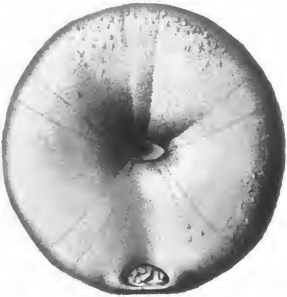

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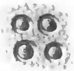

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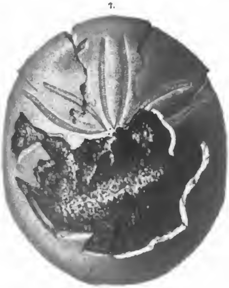

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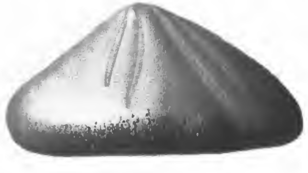


Duncan & Sladen del. A. Swain lith. Mintern Bros. imp.

Fossil Echinoidea from Kach.
Nummulitic Series

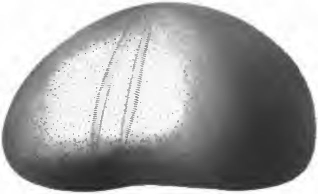
PLATE IV.

(*Nummulitic Series.*)

Figure 1. **Amblypygus altus**, Duncan and Sladen (page 16). A large specimen, side view, natural size.

2. The same, abactinal view, natural size.
3. The same, actinal view, natural size.
4. **Amblypygus pentagonalis**, Duncan and Sladen (page 18). The test, side view, natural size.
5. Abactinal view of the same, natural size.
6. Peristomial region of a specimen, natural size.
7. Marginal ornamentation, magnified.
8. Ornamentation near the apex, seen obliquely, magnified.
9. Poriferous zone and interporiferous area, magnified.
10. Poriferous zone and part of interporiferous area of an ambulacrum near the margin, magnified.
11. The apical system, magnified.

1.



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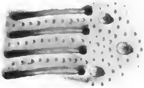

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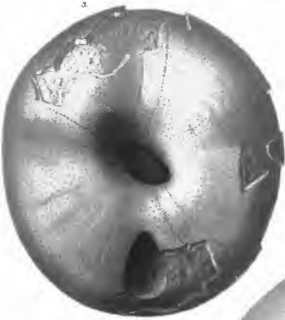

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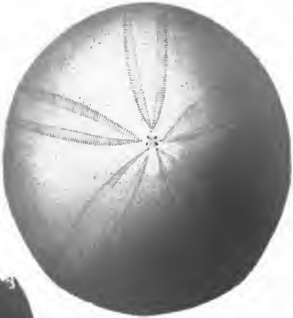

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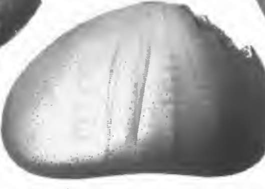

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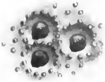

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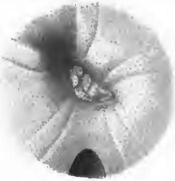

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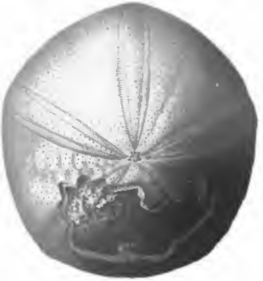

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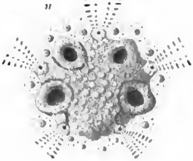

Duncan & Sladen, dir. A. Gawan lith.

Mintern Bros. imp.

Fossil Echinoidea from Kach
Nummulitic Series

PLATE V.

(Nummulitic Series.)

Figure 1. PERIPNEUSTES INSIGNIS, Duncan and Sladen (page 42). The test, side view.
2. Abactinal view.
3. Apical system, magnified.
4. A part of a posterior ambulacrum and fasciole, magnified.*
5. SCHIZASTER BALUCHISTANENSIS, variety (page 38). Abactinal view.
6. Side view.
7. Actinal view.
8. Apical system and ambulacra, magnified.
9. Large specimen (page 41), with the posterior keel worn off.

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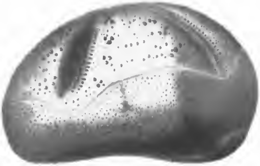

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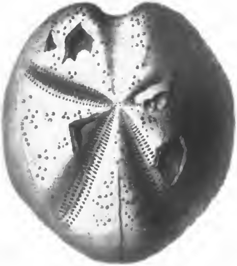

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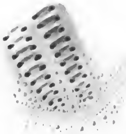

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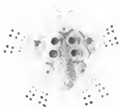

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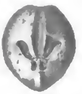

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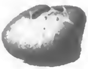

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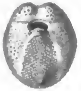

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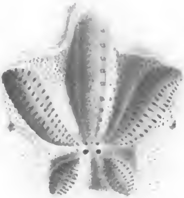

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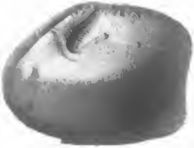


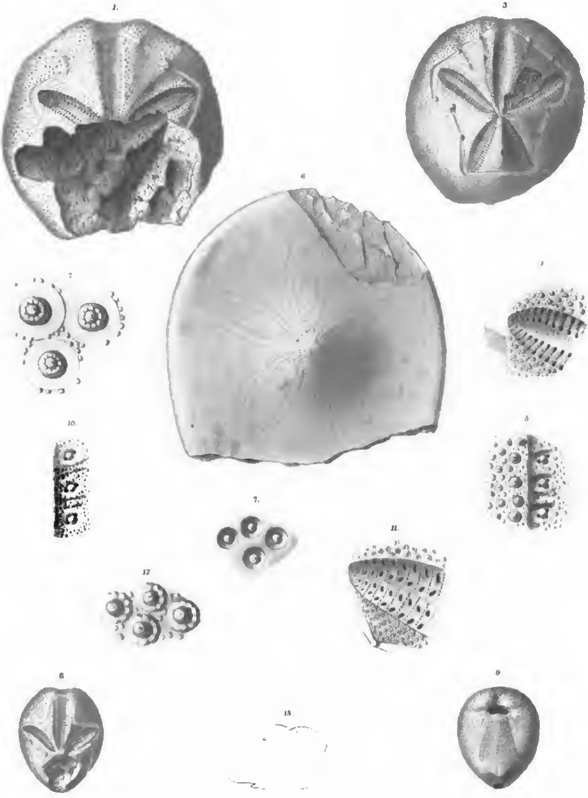
n Lan & Slater dir. A. Gawan lith. Mintern Bros. imp.

Fossil Echinoidea from Kach.
Nummulitic Series

PLATE VI.

(Nummulitic and Miocene Series.)

Figure 1. HEMIASTER, sp. (page 35).
2. Actinal ornamentation, magnified.
3. HEMIASTER DECIPIENS, Duncan and Sladen (page 34). Abactinal view.
4. Distal end of antero-lateral ambulacrum, magnified.
5. Part of anterior odd ambulacrum, magnified.
6. CLYPEASTER APERTUS, Duncan and Sladen (page 11). Abactinal surface.
7. Its ornamentation, magnified.
8. SCHIZASTER GRANTI, Duncan and Sladen (page 70). Abactinal view.
9. Actinal view.
10. Anterior ambulacral pores, magnified.
11. End of antero-lateral ambulacrum and fasciole, magnified.
12. Tubercles, magnified.



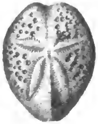
Duncan & Sladen del. A. Gowan lith. Mintern Bros. imp.

Fossil Echinoidea from Kach.
Nummulitic Series

PLATE VII.

(Oligocene and Miocene Series.)

Figure 1. **Euspatangus rostratus**, d'Archiac and Haime (page 47). Abactinal view.
2. Actinal view.
3. Posterior view.
4. The apical system, magnified.
5. A large tubercle, magnified.
6. Part of a poriferous zone, magnified.
7. A linear longitudinal section.
8. A less excised variety.
9. **Troschelia tuberculata**, Duncan and Sladen (page 67). Abactinal view.
10. Actinal view.
11. Ornamentation of odd ambulacrum, magnified.
12. A tubercle, magnified.



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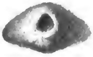

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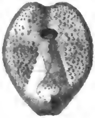

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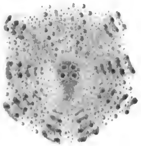

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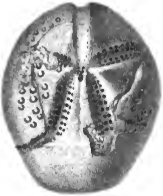

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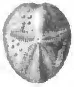

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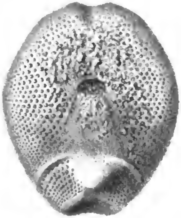

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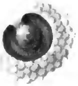

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Duncan & Sladen del.   A. Gawan lith.

Mintern Bros. imp.

Fossil Echinoidea from Kach.

Oligocene & Miocene Series

PLATE VIII.

(*Miocene Series.*)

Figure 1. Moira antiqua, Duncan and Sladen (page 64). The test, side view.
2. Posterior view, natural size.
3. Abactinal view, natural size.
4. Abactinal view, natural size.
5. Actinal view.
6. Actinal outline of a small specimen.
7. Cidaris Halaensis, d'Archiac and Haime (page 51). Part of the test, natural size.
8. Part of an ambulacrum, magnified.
9. Goniocidaris affinis, Duncan and Sladen (page 52). Part of the test, natural size.
10 to 14. Spines, natural size, of unknown species (page 53).

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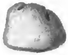

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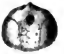

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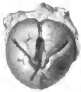

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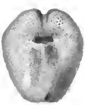

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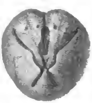

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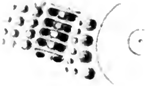

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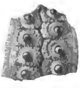

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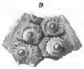

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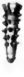

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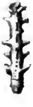

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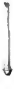

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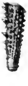

Duncan & Sladen dir. A. Gowan lith.

Mintern Bros imp.

Fossil Echinoidea from Kach.

Miocene Series.

PLATE IX.

(Miocene Series.)

Figure 1. ECHINOLAMPAS INDICA, Duncan and Sladen (page 61). Abactinal view.
2. Side view.
3. Actinal view.
8. A variety.
9. A variety.
4. A specimen with narrower petals. Side view.
5. Abactinal view.
6. Apical system, magnified.
7. Actinal system, magnified.
10. Part of a phyllode, magnified.
11. ECHINOLAMPAS WYNNEI, Duncan and Sladen (page 63). Abactinal view.
12. Actinal view.

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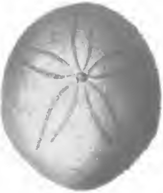

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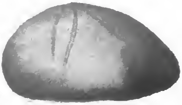

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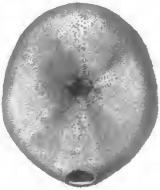

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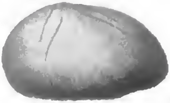

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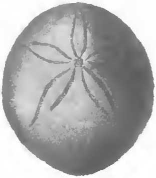

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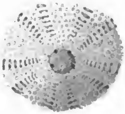

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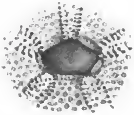

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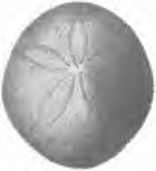

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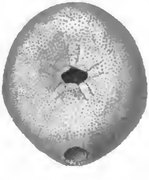

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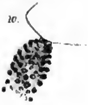

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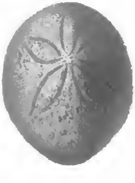

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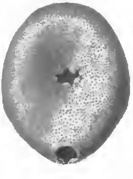

Duncan & Sladen, del. A. Gawan lith. Mintern Bros. imp.

Fossil Echinoidea from Kach.
Miocene Series.

PLATE X.

(Miocene Series.)

Figure 1. **Baeynia carinata**, d'Archiac and Haime (page 66). Abactinal surface.
2. Posterior view, slightly magnified.
3. Abactinal view of a large specimen.
4. Apical system, magnified.
5. **Clypeaster depressus**, Sowerby (page 58). Abactinal view.
6. Poriferous zone, magnified.
7. Actinal view.
8. Longitudinal section.
9. Large specimen, showing needle-pillars between the roof and base of the test.

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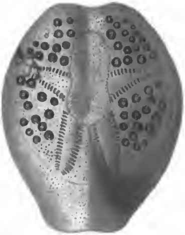

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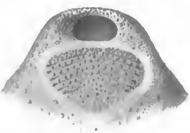

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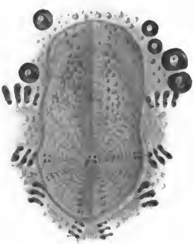

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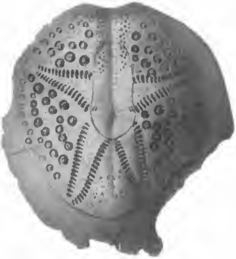

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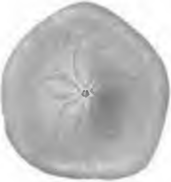

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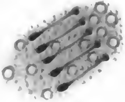

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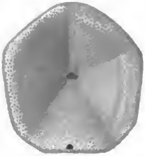


Duncan & Sladen dir. A. Gowan lith.

Mintern Bros. imp.

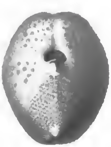
Fossil Echinoidea from Kach.
Arenaceous Series

PLATE XI.

(Nummulitic and Miocene Series.)

Figure 1. HEMIASTER CARINATUS, Duncan and Sladen (page 35). The test, from the side.
2. Abactinal view.
3. Actinal view.
4. Tubercle on actinal surface, magnified.
5. TROSCHELIA TUBERCULATA, Duncan and Sladen (page 67). Part of the apical system, showing the diminished size of the pairs of pores, magnified.
6. ARACHNIOPLEURUS RETICULATUS, Duncan and Sladen, variety (page 11). Part of an interambulacrum and poriferous zone, magnified. (*Nummulitic form.*)
7. TEMNECHINUS ROUSSEAUI, d'Archiac and Haime, sp. (page 57). The test, natural size.
8. Apical system, magnified.
9. Part of an interradium and a poriferous zone, magnified.
10. Part of an ambulacrum (worn), magnified.
11. Part of a perfect ambulacrum, magnified.

3.



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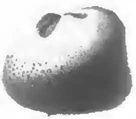

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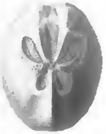

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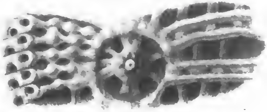

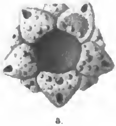

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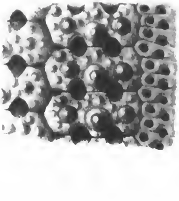

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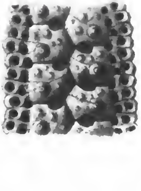

Duncan & Sladen dir. A. Gawan lith.

Mintern Bros imp.

Fossil Echinoidea from Kach.

Miocene series

PLATE XII.

(Oligocene and Miocene Series.)

Figure 1. Cœlopleurus Forbesi, d'Archiac (page 53). Apical system, magnified.
2. Euspatangus affinis, Duncan and Sladen (page 46). Abactinal view.
3. Euspatangus patellaris, d'Archiac (page 79). Actinal view.
4. Odd ambulacrum, magnified.
5. Fasciole, magnified.
6. Echinolampas sphæroidalis, d'Archiac (page 64). Abactinal view.
7. Echinodiscus Desori, Duncan and Sladen (page 60). Abactinal view.
8. Actinal view.
9. Lunule, magnified.
10. Peristome, part of, magnified.
11. Clypeaster Sowerbyi, Duncan and Sladen (page 49). Abactinal view.
12. —— Carteri, Duncan and Sladen (page 49). Abactinal view.
13. —— Waageni, Duncan and Sladen (page 58). Abactinal view.
14. —— Goirensis, Duncan and Sladen (page 59). Abactinal view.
15. —— Faloriensis, Duncan and Sladen (page 50). Abactinal view.
16. —— Goirensis, Duncan and Sladen (page 59). End of petal, magnified.

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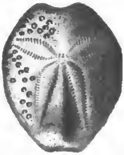

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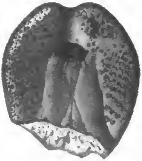

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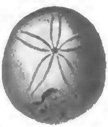

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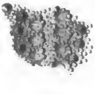

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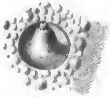

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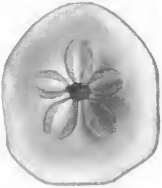

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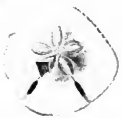

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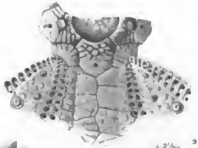

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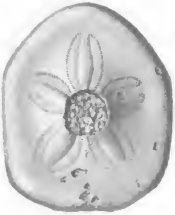

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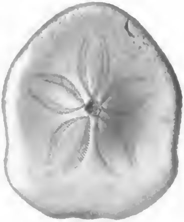

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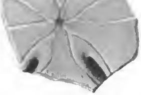

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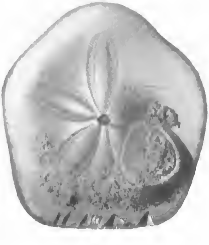

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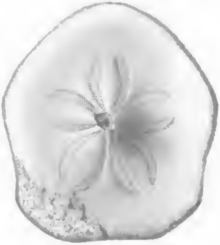

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Fossil Echinoidea from Kach.
Oligocene & Miocene Series

Mintern Bros. imp.

PLATE XIII.

(*Miocene of Kattywar.*)

Figure 1. Cidaris depressa, Duncan and Sladen (page 80). The test, natural size.
2. Ambulacral plates, magnified.
3. Diagram across an ambulacral plate.
4. Cidaris granulata, Duncan and Sladen (page 80). The test, natural size.
5. Ambulacral plates, magnified.
6. A coronal interradial plate, showing the radial granulation and the markings on the boss and partial crenulation.
7. Grammechinus regularis, Duncan and Sladen (page 82). The actinal view, natural size.
8. Ambulacral and coronal plates, magnified.
9. Temnechinus costatus, d'Archiac, sp. (page 84). A large specimen, side view.
10. An ambulacrum and part of an interradium, magnified.
11. Temnechinus affinis, Duncan and Sladen (page 86). The test, natural size.
12. An ambulacrum and part of an interradium, magnified.
13. Temnechinus Rousseaui, d'Archiac (page 84). A large specimen, diagram of side outline.
14. A depressed type, side view.
15. An interradial plate, showing unusual tuberculation and crenulation.
16. Temnechinus tuberculosus, d'Archiac (page 85). Ambulacrum and part of interradium, magnified.
17. Diagram of shape, natural size.

Plate XIII.

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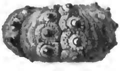

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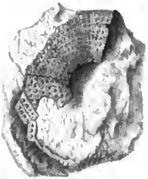

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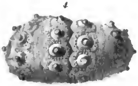

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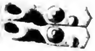

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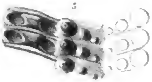

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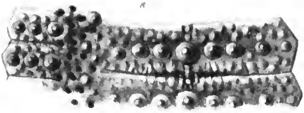

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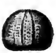

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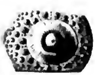

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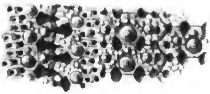

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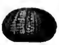

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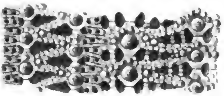

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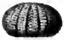

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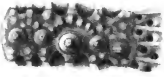

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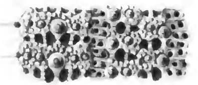

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